MICROBIAL AND PHYSICO-CHEMICAL VARIATION IN TAP WATER SUPPLY OF JHANSI

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BY

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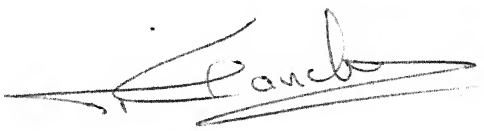
SUPERVISOR'S CERTIFICATE

I hereby Certify that this thesis entitled "Microbial and physico-chemical variation's in tap water supply of Jhansi', is an original piece of research work carried out by Miss Varsha Kanchan under my guidance and supervision for more than 3 academic years and has also carried lab work for more then 200 days for the degree of Doctor of philosophy of Bhundelkhand University, Jhansi,(U.P)



(M.C.Kanchan)

CONTENTS

INTRODUCTION

INTRODUCTION

Water one of nature's greatest gift, is the most important and precious natural resource. About three forth of the earth's surface is covered with water. It can exist easily in all the three states solids, liquid and gaseous. Water has been traced to the origin of creation and is the root of all living creature's.

The main source of domestic water in India is the surface water accumulated into river's, which is roughly assessed at 645 billion m^3. Total domestic water available from all sources including underground water in India is about 1,900 billion m^3 (Rao 1971, 72).

During the last few year's, demand's for domestic water supply has increased tremendously due to growth in population, agricultural practices and industrial usage. Improper waste disposal and over exploitation of resources has effected the quality, not only of tap water but also of underground water. This study attempts to evaluate and compare the quality of tap water, reservoir water and underground water supply of Jhansi.

Jhansi is the famous patriotic city of Maharani Laxmi Bai, Rashtra Kavi Maithli Sharan Gupta, Hockey wizard - Major Dhyan Chand, Upanyas samrat Dr. Vindravan Lal Verma, freedom fighter Master Rudra Narain, philosopher saint - Acharya Bipin Bihari Banerjee needs no introduction. It is the head-quarter of Bundelkhand region of central India and is geographicaly situated at a latitude of 25^0 - 27' N and a longitude of 78^0 - 35' E. The altitude is about 271 mitre's above mean sea level. Water is mainly supplied for domestic use through tap's. This tap water come's mainly from Pahuj & Matatila reservoirs after its treatment through water works. These reservoirs receive water through Betwa river and through rainfall sepage from its catchment area's. (Map 1 & Map 2.)

Topography of the Jhansi area is rocky and undulating with ground level varying from 224.10 m to 256.67m. above mean sea level. The area is covered by bundelkhand granite and gneisses. The bundelkhand granites are well traversed by the quartz reefs running in NE - W direction and dolerite dykes generally extending in NW - S direction. Besides these linear feature many other lineaments

are observed in the granitic terrain above base rock which is found 5, 6 to 50 m. below the surface.

Total supply of potable water in Jhansi town with the population of about 3.5 Lac's is 27.0 mld. out of which about 9.5 mld. come's from Matatila reservoir, 13.6 mld. from Pahuj reservoir and about 3.910 mld. from tube wells and some open wells through pipe lines distribution system extended to a length of 371 km.

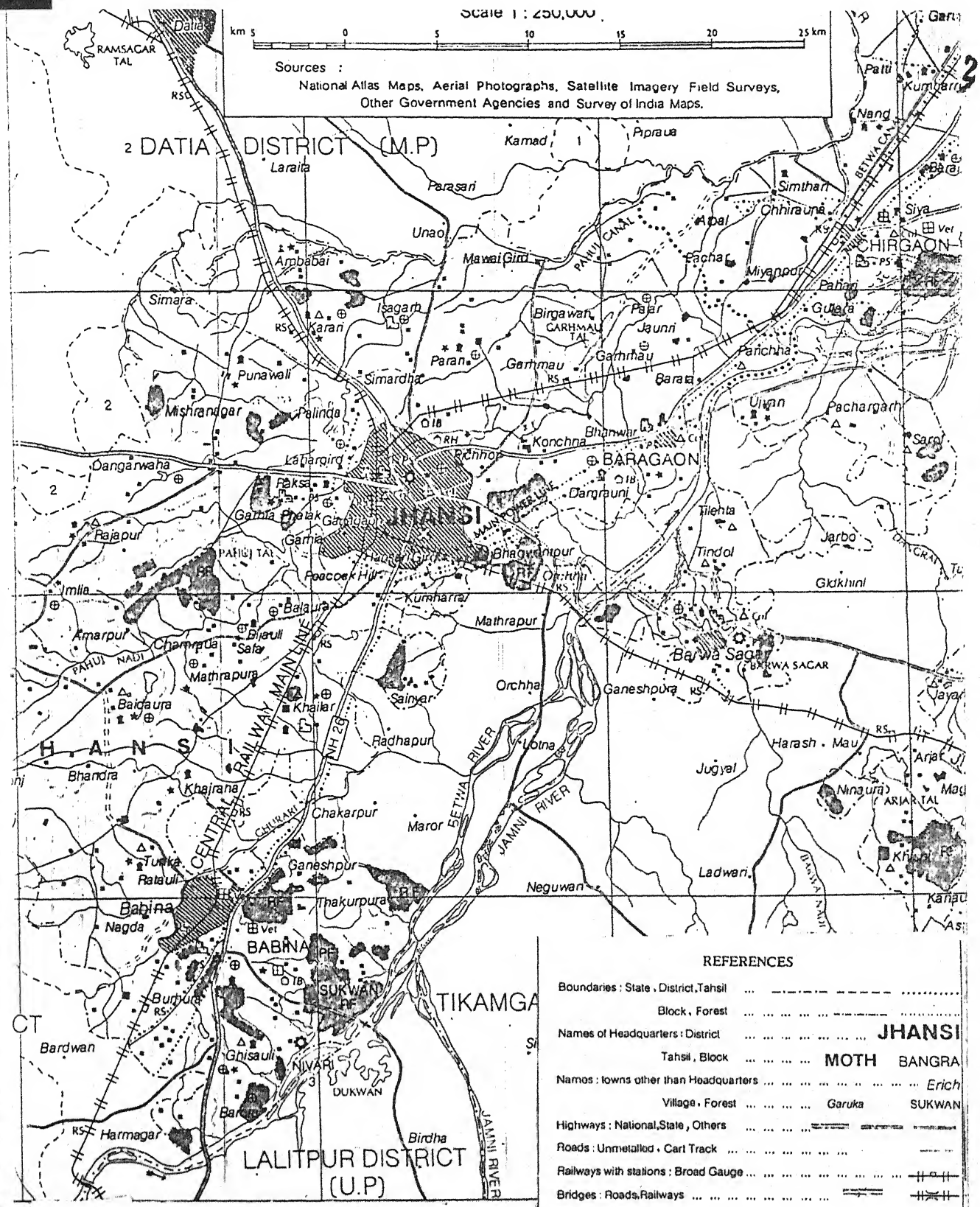
Jhansi city area face's acute water scarecity mainly because of low and erratic rainfall, high run - off and rocky terrain with low infilteration capacity and limited retention in available fracture's, fissures and joints etc. Ground water in the area occurs mainly in weathered zone's and in the vicirity of lineaments. Availability of ground water in Jhansi is very much limited and unreliable. Jhansi city as such, has to depend almost entirely, on surface sources for its water supply.

According to the record's of "World Bank Unit of Jhansi" history of existing arrangement of water supply in Jhansi town started in 1926, by pumping 1.36 mld. raw water from Pahuj reservoir through a 5.6 km. long and 225 mm. diametre mains, using steam engines benefiting the population of about 5000.

In the year 1932 - 1933, a 909 kl. clear water reservoir was constructed at Tauria Narsingh Rao. The population of the town which was 64591 souls in 1931 got water supply of about 21 Lpcd.

Supply of filtered water to the town started in 1952 by constructing a filter plant of capacity 3.9 mld. and a CWR of capacity 1363.50 kl. at Datiya Gate water works. A power transmission line was taken from Jhansi to Pahuj Dam and steam engine's were replaced by electric driver motor's and pump's. The rate of water supply to 1 lac population of the town come to about 36 lpcd.

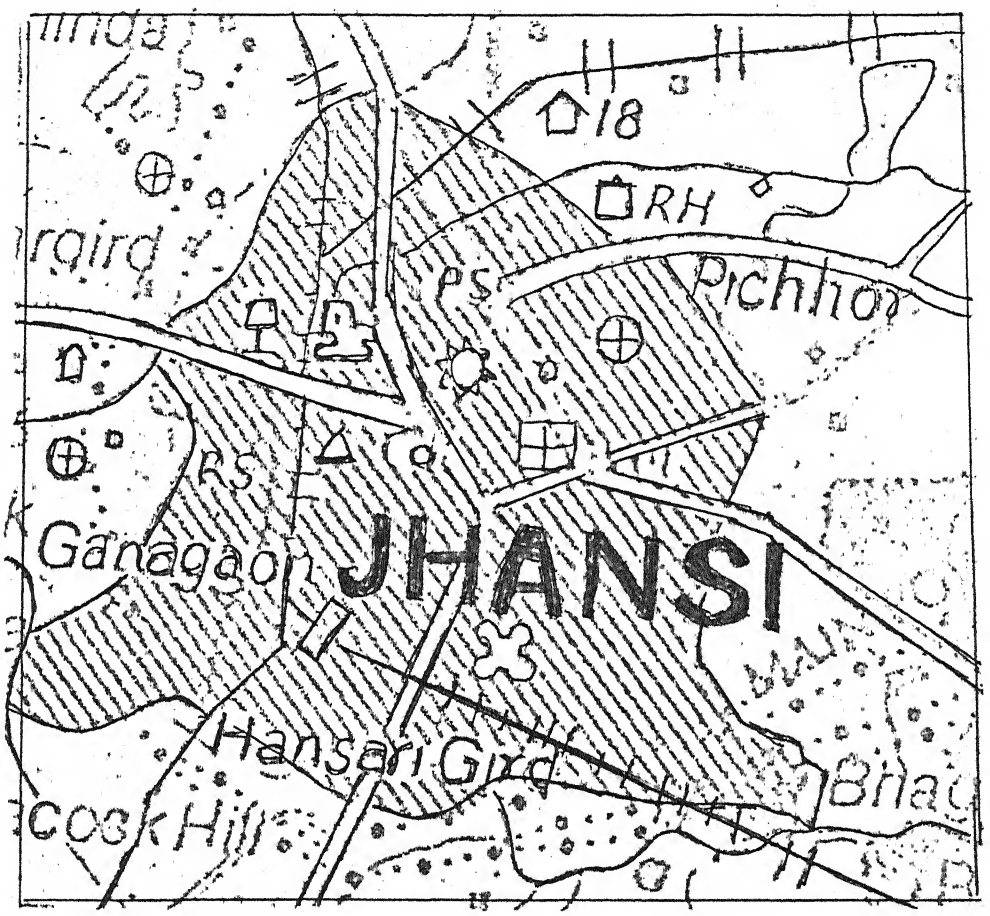
Jhansi Babina water supply scheme was executed during mid sixties. Under this project, about 45 mld. raw water was drawn from matatila reservoir, brought to Babina through a 21 km. long 1050 mm. diameter main, treated at Babina in a 45 mld. water treatment plant and then brought to Jhansi through a 27 km. long 1050 mm/840 mm/540 mm. gravity main. A 31.78 ml. CWR and 682 kl. over head tank was also constructed under this project at civil lines. With the execution and commissioning of this scheme, the total water available to Jhansi



MAP 1-

MAP OF JHANSI CITY SHOWING DIFFERENT SAMPLING LOCATIONS

Scale 1 : 250,000



MAP 2- ENLARGEMENT OF URBAN AREA OF JHANSI CITY

became 21.80 mld. (5.5 mld. from Pahuj + 16.3 mld from Matatila), thus enhancing the per capita supply to its population of about 1,55,000 in the year 1965 - 66 to about 140 lpcd. In the year 1982 - 83 (5200 m. long 90 mm. PVC. pipe lines) bringing up the total length of distribution pipeline in the town to the present 371 km. The water supply system presently available in Jhansi town mainly consists of the following :

A. Source :

1. Pahuj reservoir at a distance of about 8 km.
2. Matatila reservoir at a distance of about 46 kms.
3. Tube wells (13 Nos) and open wells (7 Nos) in the city itself. These wells however can not be relied upon to continue. Serving for a long time as their discharge are gradually declining.

B. Treatment :

1. 10.3 mld. Water Treatment Plant at Datiya Gate.
2. 45 mld. Water Treatment Plant at Babina.

C. Pumping arrangements :

At present three pump house are available in Jhansi town.

S.N.	Pump house	Discharge 1 pm.	Head M	BHP of Motor
1.	At Datiya Gate water works's	2280	40	30
		2280	40	35
		2280	40	35
		5833	50	120
		5833	50	120
		1090	24	10
		1090	24	10
2.	At Civil Lines	3030	18	33
		5115	17	40
		5115	17	40
		3788	24	40
		3788	24	40

3.	At Pulia No. 9	2724	27	25
		2724	27	25
		1363	25	12.5
		1363	25	12.5

D. Conveying Mains :

S.N.	Location	Material	Diameter	Length
1.	Datiya Gate Water Works to civil lines C.W.R.	C.I.	14"	3050
2.	Datiya Gate Water Works to Tauria Narsingh rao CWR	C.I.	9"	1610
3.	Datiya Gate Water Works to Tauriya Narsingh Rao C.W.R.	C.I.	9"	1610
4.	Datiya Gate Water Works to Spinning Mill	C.I.	9"	3000
5.	WTP Babina to Civil Lines	PSC	42"	1365
	CWR	PSC	33"	23654
		C.I.	21"	1120
6.	Hasari to Pulia No. 9	AC	12"	2430
7.	Pulia No. 9 to Nagra	C.I.	10"	650
8.	Civil Lines CWR to Tauria Narsingh Rao CWR	RCC	21"	1960
9.	Civil Lines CWR to OHT Sipri	C.I.	16"	1964

E. Storage :

A.	Clear Water Reservoir's	Storage Capacity
1.	Tauria Narsingh Rao	900 kl.
2.	Datiya Gate	1350 kl.
3.	Civil Lines	3200 kl.
4.	Pulia No. 9	680 kl.

B.	Over Head Tank	Storage Capacity
1.	Civil Lines	680 kl x 15 m.
2.	Prem Nagar	450 kl x 15 m.
3.	Pulia No. 9	450 kl x 15 m.
4.	Sipri Bazar	900 kl x 16.76 m.

F. Distribution System :

At present the town is divided into six water supply zone's. The city east (zone I & II) west (zone IV) and civil lines (zone III). The distribution system of zone IV (Sipri Zone) was reorganized under the revised estimate of Jhansi Water Supply Reorganisation Scheme - phase I (part III) costing Rs. 15.605 lac's prepared in the year 1976 - 77. The distribution system of zone V (Pulia No. 9) and zone Va (Nagra) was reorganized under the estimate of Jhansi Water Supply Reorganisation Scheme - phase I (part II) costing Rs. 11.214 lac's prepared in the year 1966 - 67.

The work of providing piped water supply to zone VI (Khushipura - Talpura area) was not taken up as these areas were not fully developed at that time.

A site investigation and pressure survey carried out in the month of Jan. to March 1991 has revealed that the area close to Tauria Narsingh Rao CWR was the only area where the population was presently getting water adequate to their requirement and at required pressure. The other old areas specially of Zone I, Zone II and some parts of Zone III earer to Zone II were acute problematic area's, where people got water hardly for half an hour to two hour's a day at very low pressure. In certain areas situated at higher elevations or at the tail end of the distribution's mains, the people have excavated pits upto distribution pipe lines and take water directly from the distribution main's by opening the ferrule connection.

There are some areas in existing zone's VI, IV and V - a which have developed fast without any piped water supply arrangement's in these area's. In the old area's (Zone I, II, IV and V) the existing distribution mains can over come

to some extent the problem of shortage of water and inadequate pressure's if more quantity of water is pumped into the system. However, in these area's, some mains will need duplication by suitable sized mains to meet future water requirements.

Given below are the summarised salient feature's of the distribution system serving the town at present.

Total distribution line's - 371 Kms

Domestic connection's :

1. Metered - 20471

2. Un metered - 449

Non domestic connection's :

1. Metered - 585

2. Unmetered - 13

Stand posts - 691

At present available potable water supply in Jhansi town is 27.01 mld.

from pahuj	13.6 mld.
from Matatila	9.5 mld
from tube wells & open wells	3.91 mld
Total	27.01 mld.

From the above record at present time, available water supply in Jhansi town with the population of about 3.5 lacs is 27.01 mld. where as the requirement of water is 69.00 mld. These data's show's that the requirement is more and water supply available at reservoir is less, hence its quality control and management is a matter of great concern.

The study area of the present work extends from Lahar Temple out side Datiya Gate, Unnav Gate in the North to Nagra, Pulia No. 9 & Cantt, in the south, and Pahuj dam in the East to Narain Bagh, Medical College in the west.

Fortnightly samples were collected during 10 to 11 Am. at 12 sampling station's, stationed widely so as to obtain samples of different localities. These are marked from A to L.

A. Sipri Bazar B. Khushipura C. Near G.I.C. College D. Over Head Tank (Mission Compund) E. Bada Bazar F. Civil Line's G. Sadar Bazar Cantt. area H. Pulia No. 9 I. City area J. Nagra K. Matatila Reservoir L. Tube well water.

Man for its expending needs of food, shelter energy etc. has exploited the natural resources at an uncontrolled rate, as a result annual rainfall has declined from 3 to 4%. Denuded land does not soak much water, as a result most of the rainfall is running waste, less water is being stored in underground aquifer which are vital for maintaining river flows in dry season and other usages.

In natural water system a complex web of climatic, physico-chemical & biological factor's are operating, to analyse it limnology is involved. The physico-chemical characteristics when changed brings about in indication of pollution. Such changes are mainly due to human activities such as rapid urbanization and industrialization coupled with unjudicious exploitation of natural resources. The discharge of domestic sewage and industrial effluents into natural water resources such as rivers, streams, lake's and reservoirs, results in alteration's of the physical and chemical properties leading to objectionable condition. Almost all major resrvoirs of India are facing such problem's.

The colour of water depends upon its optical characteristics. It is influenced by the selective transmission of light with in the water, the suspended matter, discharge of effluents from different sources and to an observer by the colour's in the surroundings which due to reflection may impart off false colour to the surface of water. The scattered light may also be reflected at the surface of finely distributed mineral particles in the water. Plankton and other organic matter impart greenish yellow colour. A blue colour is apperent in water's indicate 'oligotrophic' quality.

Temperature is the measure of intensity of heat stored in a volume of water and is highly correlated with atmospheric temperature as well as the morphometric feature's. This parameter's is of great significance as it regulate various physico-chemical parameter's as well as biological activities.

The conductivity is a measure of the capacity of the substance or a solution to conduct electrical flow. Conductivity is reciprocal of the resistance. The resistance of an aquous solution to electrical current or electron flow decline's with increasing ion contents. Hence, the pure the water is the lower is its salinity and the greater is its resistance to electrical flow. Seasonal variation in conductivity values are mostly due to the increased concentration of salts because of evaporation, the dilution, resulting from precipitation. High conductivity reflects the pollution status as well as trophic level's of aquatic body.

pH indicative of hydrogen - ion - concentration express the intencity of an acid / alkaly, depending upon its dissociation as well as the total amount that is present. The alteration of pH of water is accompanied by changes in other physico-chemical aspects of the medium. In fresh water ecosystem usually hydrogen ion concentration is towards the middle of the pH scale and show little differential affects on the majority of habitate. Fluctuation of pH may be at different sampling sites as well as in different season's. Change in pH may be due to changes of carbon - di - oxide, hardness, photosynthetic activity etc. Alkalinity have often been correlated with the productive capacity of water. It fluctuate's in different season's & places.

Chloride is essential in general osmotic salinity balance and ion exchange but metabolic utilization may not cause significant variation in the special and seasonal distribution within an aquatic body. However pollution sources of chloride may modified natural concentration greatly. Its fluctuation may also be accounted due to precipitation, evaporation humen activity, municipal waste etc.

Carbon - di - oxide is essential for photosynthesis. It enter's in water partly, directly from the atmosphere and partly with precipitation and other inputs but largly due to infilteration through the soil as well as by the metabolic activity of the organisms in water. Relationship between Co_2 and dissolved oxygen have also been observed by many worker's. Its fluctuation results changes in the total

hardness of water. Hardness depend's on the water level, algal growth and season's.

Dissolved oxygen is essential for the metabolism of all aerobic, aquatic organisms. Its distribution is important for the direct needs of many organisms and effects the solubility and availability of many nutrients, and thus the productivity of aquatic ecosystem. The oxygen balance is effected by the atmosphere, photosynthesis, respiration, decomposition and mineralization of organic matter. Thus oxygen balance becomes poorer as the input of oxygen at the surface and the photosynthetic activity decreases and as the metabolic performances of heterotrophic organisms becomes greater. On account of this the following three posibility may arise.

No. 1 - Flowing water with rapid movement having shallower depth have a more favourable oxygen balance then standing water's.

No. 2 - Input of organic matter into a water body has an adverse effect on its oxygen balance.

No. 3 - Enrichment of oxygen due to photosynthetic activity.

Oxygen from the atmoshpere enter water at the surface and is transfered to greater depth by vertical water movement. Thus its value may fluctuate at different depth's, different periods of the day and during different season's.

Biochemical oxygen demand is relative oxygen demand, it is the amount of oxygen required for biochemical degradation of organic materials and the oxygen used to oxidise inorganic materials. B.O.D thus not work indipendently. Its value depends upon many factor's, such as season's of the year, total solids, dissolved solids, suspended solids as well as the quatitative number of microbial population.

Studies on phytoplankton's and microbilogy of water have great significance in the problem's of humen welfare. The planktonic population may either be due to a single species or combination of species. They may either be confined to a part of a year or may persist throughout the year. The so called water bloom situation is confined to the lake or ponds. The reservoir water understudy brought from Matatila dam to Babina through pipe lines is not supposed to be present in similar situation. During the present work water of the reservoir was collected from such out let since we were concerned with the water

entering the supply system and the water supplied to the population in the final stages.

Generally, blue green algae and green algae dominate the algal flora due to their tolerence to meteorological condition's and physico-chemical feature's. They are often responsible for the bad taste, and odour, that make water unfit for drinking and other domestic purposes from the point of view of health and recreation. Once the formation and disappearence of such algal population is known, attempts can be make to control there growth. These algal are wide spread in fresh water's irrespective of latitude, altitude, geology of the area and origin of the water. Many attempts having made to study there population but they are confined to tanks, pools and river's but no efforts have been made to see there appearence in the pipe line water supply. As such in the present work attempts has been made to study there population monthwise in reservoir water and at station's E & I. Since at other station's, only occasional occurence of such algal population were recorded but at the above two station's there presence were not occasional.

While interrelationship between algal dencity, distribution, periodicity and environmental conditions in lake's, pond's and river's are much worked out but interaction among bacteria there distribution, periodicity, seasonal variation and their interrelationship with environmental factor's still need attention. Thus a detail survey of water supply was undertaken with a critical analysis of the coliform bacteria, the well known indicator's of feacal population.

Presently, total coliform counts despite there short commings are commenly used as indicator's of water pollution or safety. The total count of bacteria also gave us an idea about the eutrophication of lake. In the present work attempts has been made to control their population by using antibiotic's so that they may not develop into a public health hazards. Senstivity test of these organism's were done with some well known antibiotics so that when required these could be used to control their population beside the usual process of water treatment and chlorination.

During the preliminary survey the present worker have found that in various crowded localities of Jhansi water supply is of poor quality and has objectionable

smell specially during the summer's. It appears that either the filteration tank is not properly looked after or they have small treatment plant which could not meet the current demand thus they have to supply water with in a short period to meet the consumption demand. As this water may be a potential carrier of pathogenic organisms, which endangers health, the present work has been taken up to determine the potability of water as supplied to the various localities.

The quality of domestic tap water supply in Jhansi was evaluated from Sep. 1995 to Aug 1996 on the basis of physicochemical parameters and microbial parameter's attempts were made to compare it with the tube well water quality. Survey of the literature reveals that no work of any significance has so far been done on the domestic tap water problem by any workers hence, the present work has been under taken on the following lines :

Section 1 -

Meteorological records - This section deals with the general climate of Jhansi and the meterological records during the study period.

Section 2 -

Materials & Methods - This section deals with the various materials and methods used for the collection and analysis of water samples and the collectionpoints selected for taking fortnight samples of water.

Section 3 -

Review of Literature - This section deals with the available literature on the subject and literature used for study and identification of organisms.

Section 4 -

Physico-chemical Study - This section deals with the physicochemical parameter's studied. The observation made on odour, taste, colour, temperature, conductivity, pH value, chloride contents, Total hardness, total alkalinity, free carbon -di - oxide, total carbon - di - oxide, bicarbonate contents, carbonate contents, Dissolved oxygen & Biochemical oxygen demand during the study period have been tabulated and observation made have been ilustrated.

Section 5 -

Microbiological Study - This section deals with the quantitative and qualitative estimation of phytoplankton's. The observation made on the qualitative estimation

of bacteria have also been tabulated. Variation in the presence of E.coli have been reported for the study period.

Section 6 -

Discussion & Conclusion's - The observation made during the study period have been correlate & discussed in this section. On the basis of the above discussion's, conclusion's made have also been reffered.

Section 7 -

Control Measure's - In this section, attempts have been made to suggest control measures for keeping physicochemical condition's and number of organisms within the prescribed standards so as to make water potable, safe for drinking and domestic usage.

Section 8 - General summary

Section 9 - Bibliography

SECTION - 1

METEOROLOGICAL RECORDS

SECTION - 1

METEOROLOGICAL RECORD'S

Meteorological data's were recorded at the meteorological deptt. of IGFRI Jhansi. Which is about 12 km. away from Jhansi city.Unless otherwise mentioned specificially, the monthly climatic variation for 12 month's from September 1995 to August 1996 are presented in Table - 1.

The climatic condition's of Jhansi city have been described by Shankar Narayan and Dabadghao (1970); Alka Sethi (1991). On the basis of distribution of rainfall and variatin in temperature, the climate of Jhansi can be said to be typically monsonic and can be divided in to three distinct season's name, rainy, winter and summer seasons. Each season comprises of about 4 month's.

The 'rainy season' is from mid - June to mid October being the wettest period of the year. Bulk of the total average annual rainfall normally occur's during this period.

The 'winter season' starts from mid October and ends in mid February This season is characterised by low temeprature. December and January being the coldest month's of the year.

The 'summer season' begins from mid February and end's in mid - June. This season is characterised by high temperature, frequent dust laden, hot winds and storms. Jhansi is one of the hottest place in Uttar - Pradesh. Day's are hot while nights are cool.

Due to this uneven distribution of rainfall, there is often a defeciency of moisture in the soil and atmosphere during summer's and winter's while there is heavy drainage and erosion during rains.

Climatic Condition's during study period

1. **Atmospheric Temperature** - Atmospheric temerature show a seasonal variation. The minimum temperature was observed during the winter in the month of January 96 with the onset of winter in Nov., there is a gradual fall in the temperature attaining its minimum by January. The maximum temperature was observed during the summer in the month of May 96, which was the hottest month

of the year. With the onset of monsoon by the end of June there is fall in the temperature, which continued till August. (Table - 1 , Fig I & III).

The average minimum temperature value recorded was 14.4°C in the month of January and average maximum temperature value recorded was 33.7°C in the month of May 1996. This will be apparent from the fig 1.

2. **Relative Humidity** - The relative humidity varied from 31.5% to 88% where minimum value recorded was 31.5% in the month of May 1996 and maximum value 88% in August 1996. During summer air was generally dry & during rest of the period relative humidity was more than 57% (Table 1).

3. **Total Rainfall** - The total annual rainfall recorded was 946.5 mm. during the study period. Minimum rainfall recorded was 'nil' during the months of Oct., Nov., and March and maximum rainfall recorded was 330.1 mm. in the month of July 1996. (Table - 1 & Fig - II).

4. **Total No. of Rainy Day's** - During the monsoonic season, skies are mostly heavily clouded or over cast. During the rest of the year, the skies were generally clear or lightly clouded. Minimum number of rainy day's recorded was 'Nil' in the months of Oct., Nov., and May and maximum no. of rainy day's recorded was '18' in the month of July 96. (Table - 1 & Fig - II).

5. **Wind Velocity** - Winds were generally light with strengthring in the late summer and early part of monsoon.

The minimum wind velocity 0.9 km/hour in the month of December and Maximum wind velocity was 9.6 km./hour in the month of June 1996. (Table - 1)

6. **Bright Sunshine** - The data's of bright sunshine shows that brightest hour's of sunshine fall in the month of March which was about 10.0 hours / day. While the day's of least sunshine were in the month of August, which was 2.9 hours/day. (Table - 1).

7. **Evaporation** - The minimum evaporation recorded was 2.1 mm./day in the month of Jan. 96 and during the maximum value recorded was 13.9 mm/day in the month of May 96. (Table - 1).

Dabadghao and Shankar Narayan, 1970, studied the geography, temperature, rainfall and grass cover of Jhansi. Accordingly, Jhansi city is covered by red and black soils. Black soil often occur in close proximity to red soil & gradually merge into the other. Black soil vary in colour from deep through grey to chest nut. They are rich in potash, iron, lime, aluminium & calcium carbonate and megnesium carbonate. They are highly clayed and highly retentive of moisture. Red soil also cover some area of Jhansi. Red soil include red loam, yellow earths etc. The soil of this group are believed to be sedimentary formation derived from crystaline metamorphic rocks. Metamorphologicaly they can be divided into 2 broad classes : red loams and red earth's. Red soil is generally characterised by light texture with porous and friable structure, absence of lime, free carbonate's, presence of soluble salt in a small quantity (0.5%).

A comparison of the climatic conditions during the study period with that of Shankar Narayan & Dabadghao 1970, indicate's that rainfall & other conditions were almost the same.

The effectiveness of the climatic factors like temperature, precipitation and length of the dry period can be understood in a better way by means of ombrothermic diagram, Fig II. In this the thermic curve (average monthly values of temperature) and the rainfall values are drawn together. In order to bring out the length of the dry period on the graph, the scale of rainfalls is taken as double to that of the temperature. A month is considered dry when its rainfall is less than twice its average temperature (T) : $P < 2T$.

TABLE -1

MONTHLY VARIATIONS IN TEMPERATURE, RELATIVE HUMIDITY, NO. OF RAINY DAY'S WIND VELOCITY, BRIGHT SUNSHINE, EVAPORATION DURING 12 MONTH FROM SEP 95 AUG 1996.

S.NO.	NAME OF THE MONHTS	TEMPERATURE MAXIMUM ^0C	TEMPERATURE MINIMUM ^0C	TEMPERATURE AVERAGE ^0C	RELATIVE HUMIDITY (AVERAGE %)	TOTAL RAIN FALL (mm.)	No. OF RAINY DAY'S	WIND VELOCITY (Km/hour)	SUNSHINE (Hours/day)	EVAPORATION (mm/day)
1	SEPT 1995	32.0	22.3	27.01	76.5	155.0	8	3.1	7.6	4.4
2	OCT .	33.9	16.3	25.0	57.5	---	-	1.5	9.9	4.3
3	NOV. 1995	29.0	10.0	19.5	57.5	---	-	1.5	9.6	3.6
4	DEC. 1995	24.4	7.2	15.8	67.0	6.6	1	0.9	8.2	2.5
5	JAN 1996	22.1	6.8	14.4	74.0	43.4	3	1.6	7.6	2.1
6	FEB 1996	26.5	9.1	17.8	71.0	10.8	2	2.6	8.8	3.9
7	MAR 1996	34.2	14.9	24.55	50.5	---	-	4.2	10.0	7.1
.8	APR 1996	39.0	19.4	29.2	32.0	2.8	1	4.5	9.7	10.1
9	MAY	41.8	25.6	33.7	31.5	0.05	1	7.9	10.4	13.9
10	JUNE 1996	39.1	27.7	33.4	47.0	80.7	7	9.6	8.1	13.6
11	JULY 1996	33.4	25.8	29.6	79.5	330.1	18	5.8	4.3	15.3
12	AUG 1996	30.7	24.3	27.5	88.0	316.6	14	2.6	2.9	2.6

CLIMATIC CONDITIONS OF JHANSI

Fig. I -MONTHLY TEMPERATURE VARIATION

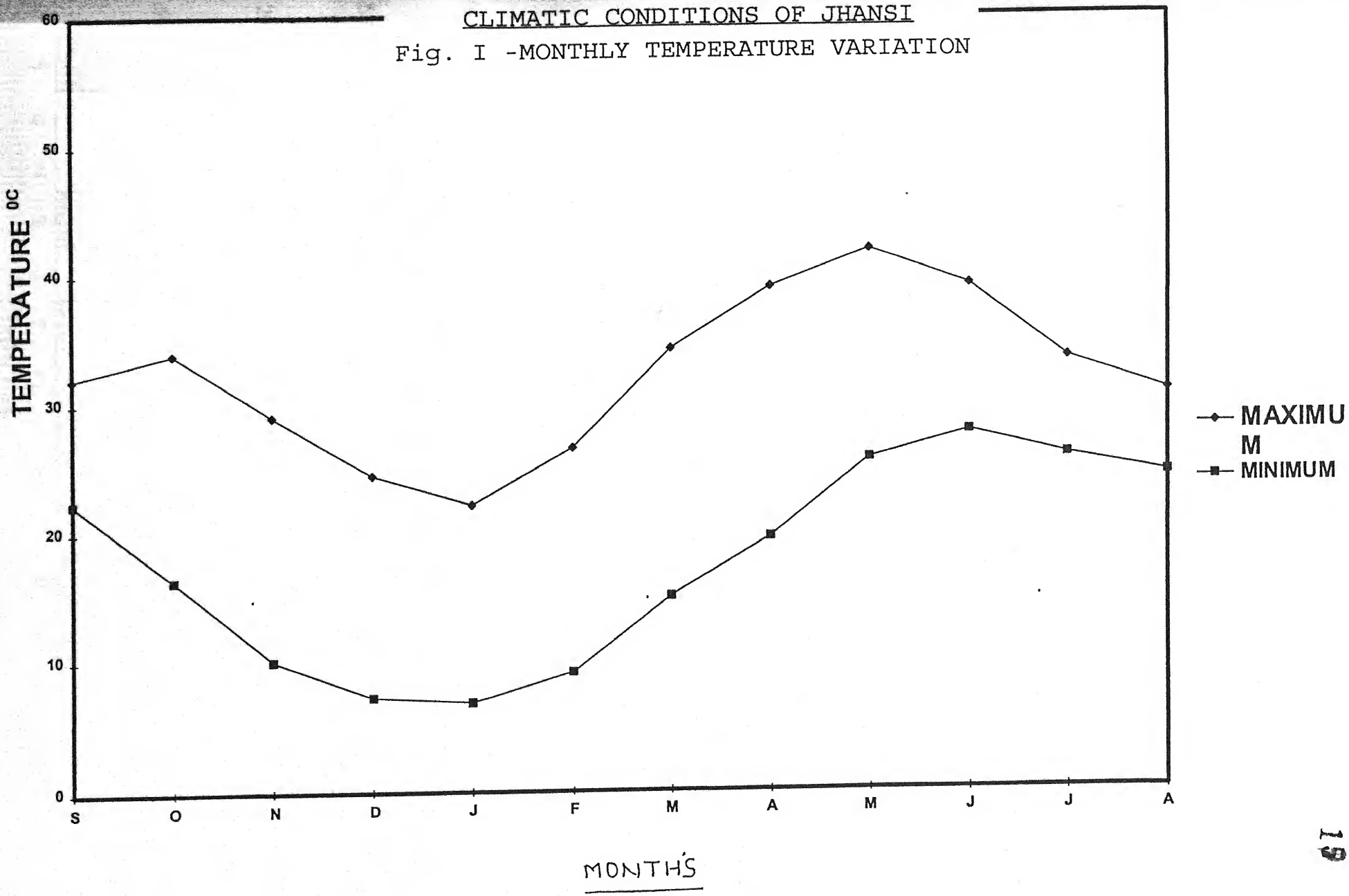


FIG - II OMBROTHERMIC DIAGRAM

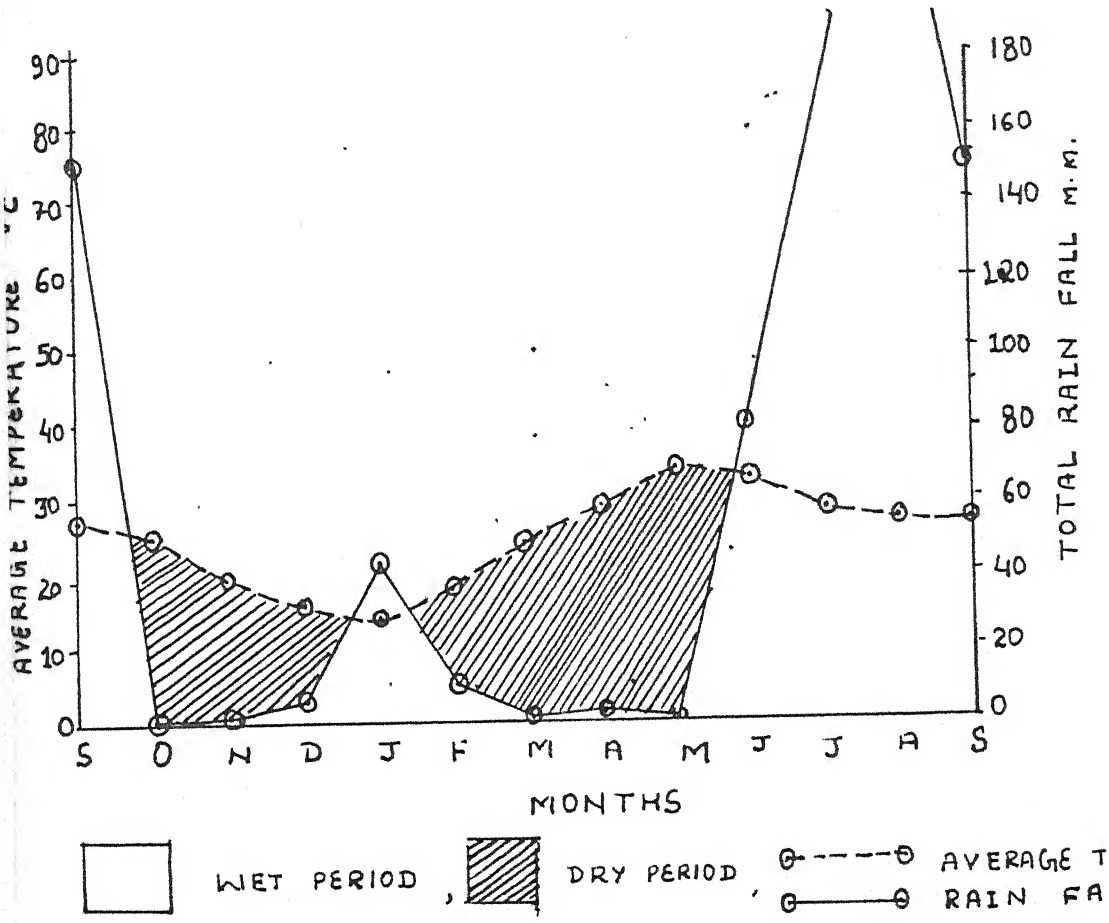
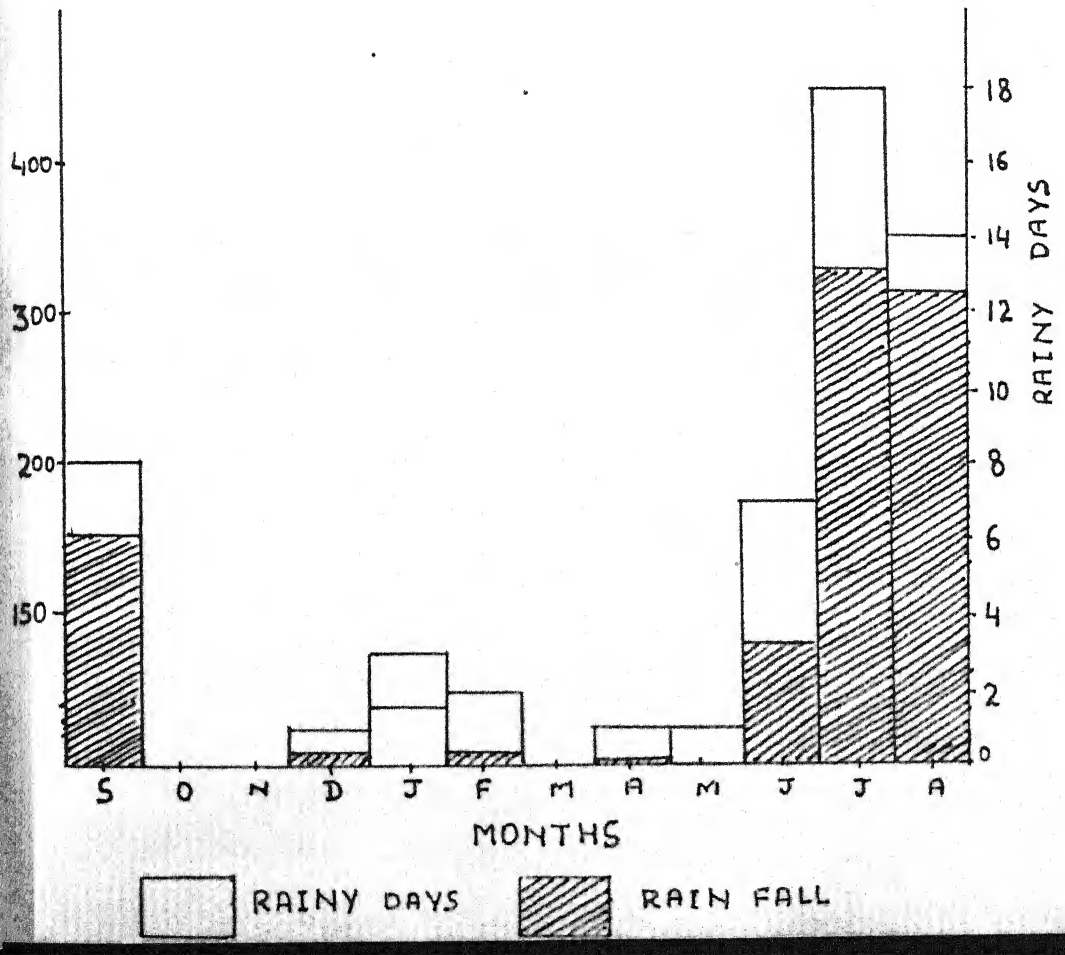


FIG - III DISTRIBUTION AND NO. OF RAINY DAYS



SECTION - 2

MATERIALS & METHODS

SECTION - 2

MATERIAL AND METHOD'S

Water sample's were collected from reservoir water, tap water and ground water for one year from September 1995 to August 1996. 12 sampling locations were selected in various localities covering the entire water supply system of Jhansi. The samples were collected at 15 days interval from the same points every time, in well stoppered, sterilized glass bottles for one year. Before collecting water from the tap was allowed to run at least 2 minutes before the samples were collected. The sample's thus collected were analysed in the laboratory within 6 hours of collection. 12 sampling locations so marked in different localities are given below from A to L.

A. Sipri Bazar B. Khushipura, C. Near GIC College D. O.H.T Mission Compound, E. Bada Bazar, F. Civil Lines, G. Sadar Bazar Cantt area, H. Pulia No. 9, I. City area, J. Nagra, K. Matatila reservoir, L. Ground water.

Physico-chemical parameters were analysed according to the methods described by Adoni et. al., (1985); I.S. : 3025 (1964) and APHA (1985), Greenberg et. al., (1975); Das (1989). Temperature was determined in the field with the help of sensitive thermometer and for PH valves and conductivity analysis portable meter were used. Total Hardness, total alkalinity, chloride contents, free CO_2, dissolved Oxygen were estimated by volumetric titration methods in the lab. Details for the analysis of the physico-chemical parameter's are given below.

1. Colour: Observation for the colour of the tap water were made visually using Sacchi disc.

2. Temperature : Temperature of the water samples were recorded with the help of maximum minimum thermometer (divided from 0^0 to 50^0 C and calibrated to 0.1^0 C) as suggested by Welch (1948); Vyas (1968) ; Schowerbel (1970); Ganapati (1960) ; Adoni et. al. (1985) and Das (1989). Reading were taken at 11 A.M. and 5.00 P.M. Necessary tables and histograms were prepared accordingly.

3. **Conductivity** : Electrical conductivity of the water samples were determined in the laboratory with the help of Systronic conductivity meter and is expressed in Micromhos. It gave an idea of soluble salts present in the samples. This method was suggested by Welch (1948); Adoni et. al (1985) ; Das (1989); A.P.H.A. (1985), Necessary tables and histograms were prepared accordingly.

4. **pH Value**. pH of the water samples were determined in the laboratory with the help of Systronic pH meter type 321. pH was also determined on the spot colorimetrically with the help of Lovibond comparator box using appropriate B.D.H. indicater (Bromo thymol blue, Phenol red). Initially, each sample was tested by adding dropwise B.D.H. indicator thereafter the alkalinity and acidity were tested respectively by way of comparing with their standard as reffered by Adoni (1985) Das (1989) and APHA (1985).

5. **Chloride Content's** : Chloride was estimated according to Mohr's method titrating 50 ml. of sample by silver Nitrate using Potassium chromate as an indicator APHA (1985). For which 50 ml of water sample in a titration flask was kept over a white paper surface. There after 2-3 drops of potassium chromate solution was added, this gives yellow colour to the sample and it was then titrated with 0.0141 N Silver Nitrate solution untill a colour change from pure yellow to brick red end point is reached. Then blank titration was also determined by titrating distilled water in the same way. This helped to chose the end point for the titration. The formula used for calculating the chloride content's of the water is given below.

$$\text{Chloride Contents mg/L} = \frac{(\text{Ml of } AgNo_3 \text{ used for sample - for Blank}) \text{ XNX35.46X1000}}{\text{ml of sample}}$$

N = Normality of titrant

6. **Total Hardness :** Total hardness was estimated according to the methods described by Adoni et. al. (1985); I.S. 3025 (1964); APHA (1967) and Greenberg (1975). For determining the total hardness of water 50 ml. of water sample in a titration flask was kept on white paper. In this solution 1 ml. of Buffer

solution (dissolved 13.5 gm. Ammonium chloride in 114 ml. Con. Ammonium hydroxide and added 86 ml. water to make the volume up to 200 ml.) is added then 2 drops of indicator Eriochrome Black T (dissolved 0,..5 gm Eriochrom Black T dye in 100 ml. of 80% ethyl alcohol) is added which turned the colour of the sample wine red. Finally it was titrated with the standard EDTA titrant (0.01 m) slowly, with continous stirring untill the wine red colour disappeared from the solution and finally changes to clear blue colour. The reading is then noted and the total hardness is calculated by the following formula.

$$\text{Total Hardness as mg/L } CaCO_3 = \frac{\text{ml. of titrant used X 1000}}{\text{ml. of water sample.}}$$

7. **Total Alkalinity** : Bicarbonate alkalinity together with carbonate alkalinity are called total alkalinity. Method used for determining total alkalinity is the one suggested by Adoni et. al. (1985) and APHA (1980). For this 50 ml. of sample is taken in 250 ml. Erlenmeyer flask. In this two drops of phenolphthalein was added. If pink colour appear then it was titrated with 0.02 N Sulphuric Acid till the colour disappear. Then 2 drops of methyl orange indicator is added this brings the colour yellow. Titration is then continued with the same 0.02 N Sulphuric acid till the colour changes to arange. If the colour does not appear pink after adding phenolphthalein then 2 drops of methyl orange is added and then titrated as above. The reading was then noted and total alkalinity was calculated by the following formula (APHA 1967).

$$\text{Total Alkalinity in mg/L} = \frac{\text{Total ml. of titrant used X N X 50 X 1000}}{\text{ml. of water sample.}}$$

N= Normality of titrant

8 . **Carbonate Content's** - According to Adoni et. al: (1985) carbonate content's is detected by titration method . For this 50 ml. of water sample to kept in a conical flask and added with 2 drops of phenolphthalein indicator. If the water sample turned pink , presence of carbonate is indicated. It is then titrated with 0.02 N Sulphuric Acid till the pink colour disappeared and the end point is noted as 'P'.

According to Adoni et. al.(1985) if 'P' is less then half 'T' (Total Alkalinity) then 'P' value will be double.

$$\text{Carbonate in mg/L} = \frac{\text{ml. of titrant 'P' X N X 50 X 1000}}{\text{ml. of water sample.}}$$

if P< 1/2 T. Then Carbonate value will be 2 P.

9. Bicarbonate Content's - This method was suggested by Adoni et. al. (1985). For testing bicarbonate contents of water 2-3 drops of methyl orange indicator was added to 50 ml. same water sample after determining the carbonate contents. Then the sample was titrated with 0.02 N Sulphuric Acid solution. Untill the colour changed from yellow to orange. Bicarbonate contents was determined by using the following formula.

$$\text{Bicarbonate contents in mg/L} = \frac{\text{Total ml. of titrant 'T' X N X 50 X 1000}}{\text{ml. of water sample.}}$$

According to Adoni et. al. (1985), when 'P' (phenolphthalein alkalinity) = 0. The bicarbonate = T (Total Alkalinity)

and if P<1/2T, Then bicarbonate = T - 2 P

10. Free Carbon-di-Oxide : Free CO_2 was determined by titration method (According to Adoni et. al. ,1985). To 50 ml. of water sample 2 drops of phenolphthalein indicator were added. In case the colour changed to pink, free carbon- di-oxide were taken as absent and when the sample remained colourless its presence was indicated. The colourless solution was titrated with standard 0.02 N Sodium hydroxide titrant and free CO_2 concentration was determined by the following formula .

$$\text{Free } CO_2 \text{ in mg/l} = \frac{\text{ml. of titrant} \times N \times 44 \times 1000}{\text{ml. of water sample.}}$$

N = Normality of titrant.

Both free CO_2 and carbonate have an end point at a common pH of 8.3

11. Total Carbon-di-Oxide : As suggested by Adoni et. al. (1985) and A.P.H.A (1980). Total carbondioxide in water is the sum of free $CO_2$and CO_2 existing in the form of carbonate's and bicarbonates. Total carbon-di-oxide was determined by values of free CO_2 and total alkalinity. Formula used for the calculation of total CO_2 of water sample is as under.

Total CO_2 in mg/L = Mg/L Free CO_2 + 0.88 (A+B)

Where as , A = mg/L of Bicarbonate alkalinity.

$$B = \frac{\text{mg/L of Carbonate alkalinity.}}{2}$$

12. Dissolved Oxygen : The occurence of dissolved Oxygen in drinking water may be mainly attributed to 2 distinct phenomenon.

1.Direct diffusion from the air 2. Photosynthetic evolution by aquatic autotrophs Dissolved Oxygen was determined by modified Winkler's method as given by Adoni et. al., (1985). Samples were collected from different localities of Jhansi city, were taken to laboratory in plastic bottles for analysis. Through delivery tube connected to the outlet tap of Ruttner's water sampler, sample were collected in 250 ml. BOD glass bottles. Delivery tube was inserted down to the bottom of the bottle and was taken out when the overflow of sample started. The samples were immediately 'fixed' for determination of dissolved oxygen by addition of a succession of the three regents : Manganous sulphate, alkaline iodide azide solution and con. Sulphuric Acid. After carefully removing the stopper of 250 ml. sample bottle, then 2 ml. of manganous sulphate reagent and 2 ml. of alkaline iodide azide reagent were added one after the other to it by means of 2 ml. pipette

dipped to the bottom of the bottle and slowly drawing out as the reagent are added. The stopper was replaced and bottle was inverted 14 or 15 times for a thorough mixing of reagents. Brown precipitate was formed which gradually settles to the bottom.

Now 2 ml. of concentrated sulphuric acid was added and shaken to dissolved the brown precipitate. 50 ml. of this solution was transfered to a conical flask placed on white background and titrated with 0.025 N sodium thio sulphate ($Na_2S_2O_3$) solution. Hypo solution was added drop by drop untill the colour turned pale yellow.. Then, 2 drops of starch solution was added to impart blue colour and the titration was continued till it becomes colourless. Blank titration was also done to eliminate the error. The dissolved oxygen was detremined with the help of the following formula.

$$\text{Dissolved Oxygen in mg/L} = \frac{8 \times 1000 \times N}{V} \times v$$

N = Normality of the titrant

V = Volume of sample.

V = Volume of titrant used.

13. <u>Biochemical Oxygen Demand (B.O.D.)</u> - Biochemical Oxygen demand is the amount of dissolved oxygen required in miligrams per litre for stablizing the biodegradable organic matter by microorganisms of the sample under aerobic condition's. B.O.D. was determined by standard method APHA (1985). It was measured by incubating the sample at 20 ^{0} C for 5 days. Samples were collected in six 250 ml. B.O.D. glass bottles without bubbling. Then added with 1 ml. of 0.05% allyl thio urea solution (Dissolved 500 mg. . of allyl thio urea in a litre of B.O.D. free water) to each bottle. Dissolved oxygen was determined of three bottles by modified Winkler's method. In this method 2 ml. manganous sulphate solution (Dissolved 182 gm. $MnSO_4$, H_2O in distilled water and diluted upto 500 ml) and 2 ml of alkaline iodide azide solution (Dissolved seperately 300 gms potassium hydroxide and 75 gm. potassium iodide in distilled water and diluted

upto 500 ml. and dissolved seperately 5 gms sodium azide (NaN_3) in 20 ml. distilled water then both solution were added to the alkaline iodide reagent) were added one after the other, then stopper was replaced and mixed thoroughly, when brown precipitate was formed, then 2 ml. of .con. H_2SO_4 was added to dissolve the precipitate. Then 50 ml. of solution was transfered in stoppered flask and titrated with 0.025 N sodium thio sulphate solution (Dissolved 6.205 gm sodium thio sulphate in freshly boiled and cooled distilled water and diluted upto 3 litre then added one pellet of NaOH for preservation). Blank titration was performed for accurate readings. This was "D_1' initial dissolved oxygen, the remaining three bottles were incubated in B.O.D. incubator at 27 ^{0} C for 3 days. After 3 days incubation oxygen concentration of these samples were also estimated as described above. This was "D_2". B.O.D. were estimated with the help of the following formula .

Biochemical Oxygen demand in mg/L = D_1 - D_2

Where , D_1 = Initial D. O. in the sample

D_2= D.O.after 3 days incubation.

Phytoplankton Collection & Analysis

Phytoplankton are chlorophyll bearing suspended microscopic organisms. Plankton sample's were collected at fort-night intervals from 11 sampling locations of Jhansi City. The time of collection varied between 9 A.M. to 12 Noon.

For quantitative and qualitative studies, 50 litres of water was passed through the plankton net. Plankton sample of one litre water was taken in a glass bottle and 10 ml. Lugols iodine (dissolved 10 gm. potassium iodide in 20 ml. distilled water then 5 gm. iodine was added to it after then 50 ml. of water and 5 gm. Sodium acetate were added and mixed it) was added to it and allowed to stand for 24 hours. Clean liquid was taken out with the help of pipette and

remaining concentrated 10 to 100 ml. sample was kept for the estimation of phytoplankton.

During the preliminary investigations counting was done by Drop Count Method as described by A.P.H.A. 1980 and Adoni et. al. (1985).

One drop of throughly shaken plankton concentration was put on the microslide with the help of standard dropper held vertically and a suitable size coverglass was applied. The microslide was then fixed under the microscope on moving stage focused one edge of the coverglass. Species-wise counting of the phytoplankton was done, then this process was repeated again for other edges and observed the whole coverglass. Organisms per liter of water sample were calculated by the following formula.

$$\text{Organisms/Litre} = A \times 1 / L \times n / V$$

Where,

A	=	Number of organisms per drop.
V	=	Volume of one drop (0.05 ml.).
n	=	Total volume of the concentrated sample (ml.)
L	=	Volume of original sample.

Estimation of the plankton were also made with the help of a "haemocyto meter" and the number's were expressed in per litre of the sample.

The planktonic net used was cone - shaped with a mouth of a diameter of 26 cm. and length of 50 cm. Planktonic net made of silk No. 25, mesh size 64, micron ie. 200 thread per inch and lower end was fitted into a detachable glass tube of 50 ml. capacity. Sample's were preserved in 5% formaline to which a little of glycerins was also added.

The systematic identification of the phytoplankton was done with the help of standard works ie. - Adoni et. al., (1985), Deshikachari(1965).

Quantitative Estimation of Bacteria

Total vible microorganisms and detection of coliform organisms specially E. coli was estimated by the standard plate count (SPC) method. In this method water samples were collected in pre-sterilized bottles. 1 ml. each of undiluted and diluted (1:10, 1:100, 1:1000) samples were transfered in seperate petri plates in triplicate then 10 ml. of Lukewarm Agar medium was added in each petridish and contents of the petriplate, was mixed by gentle circular movements . After some time medium gets solidified then each petriplate was incubate at 37^{0} c. for 2 days in an incubator. Colonies were counted using "Qubec Colony Counter". SPC per mililitre of sample was calculated with the help of the following formula .

Standard Plate Count per ml. = Average no.of Colonies per plate X Dilution.

Standard Bacteriological test of Water -

Too much reliance can not be made upon a single bacteriological analysis. One should be aware of the condition of the area from which the sample originates. Some pathogenic forms may enter in water from sewage outlets thus attempt should be made to isolate the pathogenic forms. The pathogenic forms are relatively difficult to be isolated specially from over loaded waters. There procedure for cultivation and identification are time consuming and difficult as to isolate one cell of typhoid organism would be difficult from a mixed population. At a very low concentration of such organism in water supply might cause serious Typhoid out break. Thus if an index organism Eschierichia coli is sought out, which are found in high number in the intestinal wastes, one can say that water is polluted by entric organisms. The standard technique to determine the presence of pollution specially to sewage is to look for Escherichia coli.

Escherichia coli is a short gram negative, non-spore forming rod that ferments lactose, with both acid and gas production.. Bacteriological water analysis envolves three major steps.

A. **Presumptive Test** - When tubes of Lactose Broth are inoculated with water and incubated the production of acid and gas through the break down of loctose leads to the presumption that coliform bacteria are present in water. Coliform include all species of the genera Escherichia and Aerobacter. Aerobacter is generally of soil or plant origin. Faecal sample may harbour them in about 10% of the samples. Escherichia coli is mainly of faecal origin. Two or more species of bacteria by interaction may also yeild acid and gas from lactose due to synergism. For this reason, it is important that the above presumptive test is subjected to further confirmation.

B. **Confirmed Test** : Selective media containing substances bacteriostatic for gram-positive bacteria are used so that the gram - negative species present in the presumptive lactose broth tube will have a better apportunity to develop. Endo Agar, Eosin methylene blue agar, may be used to confirm the presence of coliform as the cause of positive presumptive test. Coliform appear as coloured colonies with or without a metalic like lustre on the surface, when examined in reflected light.

C. **Complete Test :** Having isolated the suspecious looking colonies on the selective medium the next step is to select a colony and inoculate in a fresh tube of lactose broth and on standard nutrient agar. If this pure culture ferments the sugar with acid and gas production, and if a gram stain of the agar colony reveals short gram negative rods it is confirmed that water contained coliforms.

Additional test were done to further pin point and acertain the organism. These test are for convinience reffered as IMViC reactions. I-reffers to Indole test; M-methyl red test; V-refers to Voges Proskauer test and C- citrate test. The small letter 'i' is inserted purely to make the word more pronounceable and does not refer to any particular test. A typical stain of Escherichia coli is therefore IMViC + + - - while a typical Aerobacter aerogenes is IMViC - - + + . There are 14 other

combination for these 4 reactions and the organism enhabiting in between reactions are called 'Intermediates'.

M.P.N. Valuation in Water :

MPN denotes the probable number of coliform organisms present in 100 ml. of the water sample. For this, sample were inoculated in, 5 tubes of 1:10 dilution in double strength of MacConkey Broth, 5 tubes of 1:100 and 5 tubes of 1:1000 dilution in single strength MacConkey Broth. Then inoculated tubes were incubated at 37 ^{0} c. in an incubator for 2 days and examined each tube at the end of 24 and 48 hours for the formation of acid and gas production.

Statistical Processing Of The Data

Data collected was statistically analysed with the help of Standard formula given in ' Standard Statistical Work' of Schefler (1969).

Mean - Mean is ' the sum of all the members of a distribution divided by the number of members in that distribution' and was calculated with the help of the following formula :

$$\bar{X} = \frac{\sum x}{N}$$

Standard Deviation : Standard deviation is the 'square root of the sum of squared deviation's from the mean' and was calculated by the following formula.

$$SD = \sqrt{\frac{\sum x^2 - (\sum x / N)^2}{N - 1}}$$

Standard Score - Standard score is 'the number of standard deviation's above or below the mean of a distribution' and was calculated by substituting the obtained values in the following formjula :

$$Z = \frac{x - X}{Sd}$$

Standard Error - Standard error is'the relation of standard deviation of a distribution with respect to square root of number's in the distribution' and hence can also be called as standard error of the mean and was calculated by the following formula :

$$SX^{-} = \frac{SD}{\sqrt{N}}$$

Variability - Variability or range of mean in the population often called as estimation is ' the mean range on a particular confidence limit in the given distribution' and was calculated with the following formula :

$$Va = X^{-} \pm SD(Z).$$

SECTION - 3

REVIEW OF LITERATURE

SECTION 3

REVIEW OF LITERATURE

In India the work on hydrobiology has been done by many workers e.g. Ganapati 1955 on "hydrobiological investigation of the stanley reservoir and river Cauvery"; Krishnamurthy et.al., 1965 has done hydrobiological studies on Gandhi Sagar tank ; Das & Shrivastava 1956 a,b, worked on quantitative studies of fresh water plankton ; Dubey & Verma 1966, worked on hydrobiological studies of Budhwasi Tank, Seoni, M.P.; Kaushik et. al., 1988, studied on hydrobiology of Vivek Nagar pond, Gwalior (M.P.).

Zutshi et.al., 1980 worked on comparative limnology of nine lakes of Jammu and Kashmir, Himalaya ; Pandit et.al., 1991, worked on benthic communities of inland water's of India; Zutshi and Vass, 1973, 78, 82, studied on variation in the water quality of Kashmir lake and limnology of Dal lake, Kashmir ; Vashista, 1968, 79, worked on limnology of Sukhana lake, Chandigarh, India and on pollution in Chandigarh water's. Correlation between physico-chemical parameter's and phytoplankton were done by Kaul, 1977, while making Limnological survey of Kashmir lake. Detailed researches on physico-chemical and biological characterstics of lake were carried out by Juday, 1915-16; Juday & Birege, 1933, on the carbon -di-oxide and pH of the lake water. Correlation between physico-chemical and biological factor's for Indian fresh water were reported by Ganpati, 1962, on the basis of five years investigation of the Almati reservoir; Ganapati, 1955, on diurnal variation's in dissolved gasses, pH value and some of the important dissolved substances of biological significance in three temporary pools at Mettur dam ; Tiwari et.al., 1985, worked on solubility of oxygen in pure water; Tiwari et.al., 1986 c, correlated water quality parameter's of the ground water of Meerut district ; Tiwari ,1989 b, on pollution of the river Jhelum and correlation among its water quality parameter's ; Das, 1957, 59, studied on the ecology of fresh water of India ; Das 1982, worked on drinking water management in Uttar Pradesh; Das & Pande 1978 a, b, studied lake pollution as evidenced by physico-chemical and biological parameter's ; Das, 1978 a,

correlated high pollution of Nainital lake with biological indicator's ; Das & Upadhyay 1979, studied quantitative and qualitative fluctuation's of plankton's in Nainital & Bhimtal lakes ; Kaushik, 1987, studied on limnology of Matasya Sarovar ; Dhamija and Jain 1997, worked on polluted lentic water body of Jabalpur with special reference to physico-chemical and biological parameter's; Alimanzoor & Tiwari, 1988 c, correlated water quality parameters of some ancient tank of Assam ; Chakarvarty et.al., 1997, investigated abiotic factor's like temperature, pH, dissolved oxygen, free Co_2, carbonate, bicarbonate alkalinity and their role in plankton production in Monghyr, (Bihar) and they found direct correlation between abiotic factors and planktonic population ; Krishna Murthy & Bharati, 1997, revealed that high value of pH, turbidity, conductivity, dissolved oxygen, bicarbonate, total Hardness influence the occurence of Euglenophyceae of Kali river around Dandeli, Karnataka; Balsare, 1982, studied on ecology of surface water; Balsare, 1991, worked on safe drinking water for tropical belt from surface water ; Khanka, 1983, studied on physico - limnological analysis of Naina lake and Bhimtal lake in Kumaun; Khanka, 1991, worked on physical limnology of Himalayan lakes, U.P. India; Ayappan, 1987, investigated limnology and microbial ecology of a lentic habitate.

Analysis of water sample's for physico-chemical and bio-logical parameter's forms the bases of limnological investigation's . The method's of studies are given by Welch 1948; Hutchinson 1967; Golterman 1969; A.P.H.A. 1967, 80, 85; Lind, 1974, Adoni et.al., 1985; Das 1989 ; I.S. :3025, 1964 ; I.S.I. 1982 ; Greenberg et.al., 1975 ; Schwoerbel, 1970 etc.

Temperature factor in detail has been studied by Prasad, 1983, Young and Zimmerman, 1956, Zafar, 1971 ; Gupta Mehrotra, 1991 ; Nalin K. Shastree et.al. 1991 ; Sivakumar et.al., 1989 etc. Many worker's observed temperature factor of different rivers like, Ganga at Kanpur, Saxena et.al., 1966 ; Kalinadi near Mansurpur and found that it had on appriciable effect on dissolved oxygen and Biochemical oxygen demand, Verma & Dalela, 1975; river Yamuna at Agra, Dakshini & Soni 1979 ; river Jhelum at Kashmir, Shah , 1988 ; river Damodar,

Sinha, 1988 ; river Ganga at Patna Ghosh and Sharma, 1988 ; river Bandi , Rana and Parliya, 1988 etc.

Electrical conductivity is the measure of capacity of substance or solution to conduct electrical current. Cunductivity is good and rapid measure of the total dissolved solids. Many worker's worked on this parameter's and its effect on phytoplankton's like, Juday and Birge, 1933 ; Rodhe, 1949 ; Otsuki and wetzel, 1974 ; Trivedi et.al., 1985 ; Rawson, 1960 ; Nalin K. Shastree et.al., 1991; Dakshini & Soni, 1979 ; Misra and Saksena, 1991 etc.

pH is an important factor depecting the chemical and biological conditions of the natural water. Various worker's like Atkin, 1922, Lund, 1934 ; Srivastava, 1967 ; Gupta and Mehrotra, 1986 ; Alabi, 1971 b, studied on correlation between hydrogen ion concentration's and water molds. pH of water also gives an idea to the type and intensity of pollution ; Verma et.al., 1984. Saxena et.al., 1966, observed pH of Ganga river generally above 8 in all the season's except in rainy season. Chandra- prakash et.al., 1978, found the alkaline nature of the river Jamuna at Agra. Palhariya and Malviya, 1988, recorded maximum pH 11.5 in river Narmada.

Thresh et.al., 1944, pointed out that high chlorides are generally indicator of large amount of organic matter in water. According to Goel et.al., 1980, chloride contents also increase with the degree of eutrophication. Chloride factor in water has been studied by many worker's like, Saxena et.al., 1966, on river Ganga at Kanpur ; Mahadevan and Krishnamachary 1983, on river vaighi ; Somsheker, 1984, on river Cauvery ; Ajmal et.al., 1985, 88, on Kalinadi; Palhariya and Malviya 1988, on Narmada river ; Shah, 1988, on river Jhelum; Ghosh and Sharma, 1988, on river Ganga at Patna ; Rana and Parliya 1988, on river Bandi. Chlorides of different metals remain dissolved in water and effect the rate of metabolism of aquatic organisms directly. This fact has been reported by Atkin, 1922 ; Venkateshwarlu, 1965, 69 ; Unni 1969. Some other worker's also worked on chloride contents of water like, Gonzalves & Joshi 1946 ; Zafar, 1964; Lakshminarayana 1965 ; Singh 1965 ; Munawar, 1970 a & b; Khan, 1981. Khulbe 1981, found that chloride had an adverse effect on the fungal occurence. Pagon,

1970, considered chlorides as fungi toxic. According to Gupta and Mehrotra, 1991, chloride contents of water shows an inverse relationship with temperature and fungi.

Gupta & Mehrotra, 1991, concluded that calcium hardness of water may play an indirect role in the growth and occurence of water molds by influencing other physico-chemical character's of water. Some other worker's like, Dayal and Tandon 1963 ; Khulbe 1981, found that calcium Hardness is quite insignificant factor's in the occurence and growth of the water molds. Many worker's worked on factor's like carbon-di-oxide & Hardness of water like Palmer 1980 ; Gulati 1964, on Nainital lake and Govind Sagar.

Total alkalinity plays a prominent role in altering the pH value so as to cause a tremendous change in the flora and fauna, according to Nygaard, 1949 ; Ganapati, 1960 ; Tandon and Singh, 1972 ; Moss, 1973 ; Rana, 1977 etc. Studies on alkalinity, caused by disolved carbon-di-oxide have been carried out by Whipple and Parkar, 1902 ; Moss, 1973 etc. Alkalinity caused by carbonate's has been carried out by Moss 1973 c. According to Nalin K. Shastree, 1991, carbon-di-oxide is essential for photosynthesis. Mandal & Hakim, 1975, found direct correlation between free CO_2 and bicarbonate alkalinity in fresh water pond at Bhagalpur. Other worker's also reported direct correlationship between free CO_2 and bicarbonate like Pearsall, 1930 ; Howland, 1931 ; Zafar, 1964 and Munawar 1970 b. Some other worker's like chakarabarthy et.al., 1959 ; Michael 1964, 1969 and Marshall and Falconer, 1973 worked on the factor alkalinity and found highest value in summer and lowest value in monsoonic season. Gupta and Mehrotra, 1986, 91, observed that total alkalinity and temperature show direct correlationship with each other. While total alkalinity, showed inverse correlations with water molds. According to Adoni, 1975, productivity showed an inverse relation with beicarbonates and there is always an equilibrium relationship between free CO_2, carbonate, bicarbonate, OH and H in sagar lake.

Carbon-di-oxide is also very essential factor of water. Many workers like Whipple and Parker, 1902 ; Birge and Juday 1911 ; Pearsall, 1930 ; Ganapati, 1943; Gonsalves and Joshi, 1946 ; Rao 1964 ; Saha et.al., 1971 ; Singh, 1965 ;

Mandal & Hakim, 1975, worked on various physicochemical parameter's of water and observed inverse relationship between carbon-di-oxide and dissolved oxygen. Manoharachary, 1979 d ; Rao and Manoharachary, 1983, showed insignificant correlation with microbial member's. According to Gupta & Mehrotra, 1991, in brahma sarovar tank Kurukshetra, free carbon-di-oxide and occurrence of water molds shown direct correlationship with each other.

Presence of dissolved oxygen is essential to maintain variety of forms of biological life in water, it is also effected by waste discharges. Saxena et.al., 1966, worked on river Ganga, near Kanpur and observed lowest value of dissolved oxygen during summer. Verma and Dalela, 1975, obtained maximum and minimum dissolved oxygen in Kali Nadi near Mansurpur. Many other worker's also worked on this parameter's like, Chandraprakash et.al., 1978, on Yamuna river at Delhi ; Mahadevan and Krishnamachry , 1983, on river vaighi ; Jabanesan et.al., 1987, on Cooum river ; Palhariya and Malviya 1988, on Narmada river at Hoshangabad ; Shah 1988, on river Jhelum at Kashmir and Sinha, 1988, on river Damodar at Bihar. Some other workers found inverse correlationship between dissolved oxygen and temperature like Welch, 1957 ; Hussainy, 1967 ; Singh and Mahajan, 1987 ; Zutshi and Vass, 1978 ; Agarwal et.al., 1978 ; Hannan, 1979 ; Gupta and Mehrotra, 1986 ; Yadva et.al., 1987 ; Charlton and Rao, 1983 ; Nalin K. Shastree et.al., 1991 ; Palmer, 1980, observed that dissolved oxygen also effects the aquatic and microbial population of water. Alabi 1971b ; Manoharachary, 1978 and Misra 1991, observed an inverse correlationship between dissolved oxygen and temperature. Gupta & Mehrotra, 1991, found that water having 4.1 to 15.4 mg/L of dissolved oxygen is favourable for the growth of aquatic phycomycetes.

Biochemical oxygen demand represents that fraction of organic matter which is degraded and easily assimilated by bacteria. It is a good indicator of the organic pollution and it helps in deciding the suitability of water. Notable work has been done on biochemical oxygen demand of water by Shardendu and Ambasth, 1988 ; Zafar 1966 ; Zutshi and Vass, 1982 and Nalin K. Shastree, 1991. They found low value of biochemical oxygen demand in colder month due to low

quantity of total solids, dissolved solids and suspended solids and low quantitative number's of microbial population.

Microbial activities on aquatic organic matter and its effects on biological activities of phytoplankton have been revealed by the studies of Basu, 1965; Vijayaraghwan, 1971, a and Shardendu et. al., 1980. Bagde and Verma, 1991 observed that highest temperature favoured the growth and multiplication of coliform bacteria. According to Rheimheimer, 1978, high temperature exert a harmful effect upon the survival of some organisms especially those capable of producing disease. Bagde and Verma, 1991, saw direct correlation between coliform bacteria pH value and electrial conductivity. Coliform bacteria grew best at higher temperature. Bagde & Verma, 1991, studied on interaction between coliform bacteria and physicochemical parameter's. They observed average count of the coliform bacteria in lake water varying from 1.7×10^2 to 2.4×10^3 /100ml. However when pH and electrical conductivity of water were recorded highest in the month of June, coliform counts were also highest and during winter electrical conductivity & pH were lowest, coliform count were also lowest.

Bagde and Verma, 1991, also found direct correlation between total hardness and coliform bacterial count. They found that when total hardness were highest coliform count were also highest and when total hardness were lowest total coliform were also lowest.

Thimann, 1964 ; Bagde and Verma, 1991, found that growth and reproduction of microogranisms is much affected by pH in water and most aquatic microbs grow in between 6.5 to 8.5 pH. Morrissette & Mavinic, 1978, found that microorganisms need oxygen to maintain their metabolic process. According to Gonzalves and Joshi, 1964 ; Hannan, 1979, there is an inverse relationship between coliform count and dissolved oxygen. They found high coliform counts with low dissolved oxygen in summer's and low coliform count's with high dissolved oxygen in water.

Hannan, 1979 ; Bagde & Verma, 1991 and Agarwal et. al. , 1976 a, b, found direct relationship among coliform counts and biochemical oxygen demand.

Bagde and Verma, 1991, found higher B.O.D with higher coliform counts and lower B.O.D with lower coliform counts.

Physicochemical parameter's also indicate the pollution of water. Hantge 1978, studied the pollution of Nahe river in Garmany ; Hirata et. al., 1979. monitored the quality of water and sediments of the Yodomogawa river and reported that the pH, conductivity and chlorides were found to be high in polluted areas. Shayamsundar 1988, studied the water quality of river Jhelum in Kashmir and recorded seasonal variation in water quality. Shah, 1988, also studied water quality of river Jhelum in Kashmir and concluded that river water is becoming more and more hard and alkaline day by day ; Misra and Saxena 1991, worked on pollutional ecology with reference to physico - chemical characterstics of Morar (Kalpi) river, Gwalior (M.P.) ; Kudesia et. al., 1992, studied on pollution of drinking water quality of village Kamalpur, Merrut ; Bhattacharya et. al., 1991, monitored quality of water in North Eastern India in relation to health risk among the rural population ; Chandra et. al., 1984, worked on pollution of Rihand reservoir ; Chatterjee, 1990, studied on comparision between water quality and biological characterstics of two lakes of Puri district; Chatterjee, 1992, studied on water quality of Nandankanan lake ; Tripathy and Adhikary, 1990, studied on water pollution of river Nandira ; Swain and Adhikary, 1994, studied on quality of water of Swetaganga Tample tank, Puri ; Naidu, 1990 worked on quality of water of reservoir and tample tank in Tirupati.

Many worker's worked on ground water of India. Banerjee, 1983, studied the management plan of ground water in, Calcutta ; Handa, 1983, 86, studied hydrogeochemical zone in a few places in India ; Ramachandaran et. at., 1991, revealed the influence of agrogeochemicals on the ground water quality in the cultivated area in North Madras; Rosburg, 1985, attributed the quality of ground water in a coastal aquifer due to tidal fluctuation's ; Elango, 1992, worked on ground water quality in coastal region of south Madras ; Mittal, et. al., 1994, studied on ground water quality of Patiala city.

SECTION - 4

PHYSICOCHEMICAL STUDY

Section - 4

PHYSICO-CHEMICAL STUDY

In the present study fortnight samples for the study of physicochemical and microbial properties of water were collected from 12 different sampling location's i.e. from A to L and observation's recorded are given monthwise for one year from September 95 to August 96. These observation's are given in Table 2 to 13 for all the 15 parameter's under study. Table 14 and Histogram 14A. represents seasonal variations in temperature for one year at locations A to L. Similarly Table 15 and Histogram 15A. show variation in electrical conductivity. Variation's in pH value, chloride contents, Total Hardness and total alkalinity are given serialy in Talbe 16, 17, 18 and table 19 and Histogram 16 A, 17 A, 18A, 19A. Variation's in the rest of the physico-chemical parameter's i.e. carbonate, bicarbonate contents, Free CO_2, Total CO_2, dissolved oxygen and Biochemicaly oxygen demand have been given successivly in the Table 20,21,22,23,24,25 and Histogram 20A, 21A, 22A, 23A, 24A, 25A. Simultaneously with the study of physicochemical properties, phytoplankton and microbial population were also detected during the course of study.

Average values of 12 month data's for different parameter's & sampling location's have been tabulated and compared with the Indian standards in Table 42.

1. Odour : During the present investigation it has been found that sampling location's A, B, C, D & G showed unobjectionable smell during the whole year. Sampling location 'E' showed earthy and musty smell in the months of April, June and August. At the sampling location 'F' water had objectionable smell during the month of May. Sampling location 'H' showed objectionable smell during the months of June & July. Sampling location 'I' showed earthy & musty smell during the months of April, May, June and July. At sampling location 'J' objectionable smell was found in the months of June, July.

From above it is clear that at the sampling location's A, B, C, D & G water had unobjectionable smell. At other sampling location's E, F, H, I & J showed objectionable earthy & musty smell in summer season and rainy season.

PHYSICO - CHEMICAL CHARACTERSTICS OF TAP WATER FROM SAMPLING LOCATION'S A TO K DURING THE MONTH OF SEPTEMBER 1995

S.N.	PARAMETERS	SAMPLING LOCATION'S										
		A	B	C	D	E	F	G	H	I	J	K
1	Odour	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable	Smell	Nonobject-ionable	Nonobject-ionable	Earthy smell	Earthy smell	Nonobject-ionable	Earty & musty smell
2	Taste	" "	" "	" "	" "	Slight bitter	" "	" "	" "	Slight bitter	" "	" "
3	Colour	colourless	colourless	colourless	colourless	greenish	colourless	colourless	yellowish	slight yellowish	colourless	greenish
4	Temp (°C)	30° cg	29° cg	28°cg	28°cg	29° cg	28°cg	27° cg	30° cg	29° cg	27° cg	29.6°
5	Conductivity (Micromhos)	250.00	250.00	290.00	290.00	560.00	260.00	250.00	570.00	300.00	290.00	280.00
6	pH Value	7.50	7.40	7.80	7.70	6.95	7.50	7.50	6.89	7.80	7.50	8.00
7	Chloride Contents (mg/L)	22.00	20.50	35.50	28.00	29.00	21.00	16.90	42.00	133.00	29.00	28.40
8	Total Hardness(m	170.00	122.00	134.00	134.00	336.00	120.00	104.00	320.00	586.00	135.00	175.20
9	Total Alkalinity(mg/	112.00	105.00	109.00	120.00	386.00	116.00	96.00	240.00	250.00	122.00	181.80
10	Carbonate (mg/L)	7.92	3.52	7.92	3.52	10.56	1.76	3.52	13.20	31.68	5.64	5.30
11	Bicarbonate (mg/L	531.50	462.00	901.90	528.00	8415.00	306.20	422.00	3379.00	8140.00	795.00	1123.50
12	Free Carbondioxid (mg/L)	112.00	105.00	109.00	120.00	386.00	116.00	96.00	240.00	250.00	122.00	181.80
13	Total Carbondioxid (mg/L)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	Dissolved Oxygen (mg/L)	7.80	7.40	7.90	7.90	5.90	8.00	8.20	6.00	6.50	7.90	7.05

TABLE - 3

PHYSICO - CHEMICAL CHARACTERSTICS OF TAP WATER FROM SAMPLING LOCATION'S ATO K DURING THE MONTH OF OCTOBER 1995

S.N.	PARAMETERS	SAMPLING LOCATION'S										
		A	B	C	D	E	F	G	H	I	J	K
1	Odour	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable	Earty & musty Smell	Nonobject-ionable	Nonobject-ionable	Earthy smell	Earty & musty Smell	Nonobjec-ionable	Earty & musty smell
2	Taste	" "	" "	" "	" "	" "	" "	" "	" "	" "	" "	Slight bitter
3	Colour	colourless	colourless	colourless	colourless	Slight yellowish	colourless	colourless	Light yellow	Light yellow	colourles	greenish
4	Temp (°C)	22° cg	21° cg	20°cg	20°cg	21° cg	21°cg	22° cg	35° cg	22° cg	21° cg	24°
5	Conductivity (Micromhos)	240.00	245.00	230.00	230.00	580.00	240.00	235.00	550.00	530.00	220.00	320.00
6	pH Value	7.40	7.50	7.40	7.40	7.00	7.45	7.35	6.90	7.10	7.50	7.90
7	Chloride Contents (mg/L)	23.00	25.00	33.00	31.00	24.00	27.00	25.00	40.00	35.00	22.00	22.20
8	Total Hardness (mg/L)	148.00	138.00	138.00	137.00	380.00	130.00	140.00	310.00	280.00	140.00	136.00
9	Total Alkalinity (mg/L)	119.00	139.00	122.00	120.00	340.00	122.00	120.00	235.00	139.00	120.00	168.80
10	Carbonate Contents (mg/L)	0.00	20.00	0.00	0.00	56.00	0.00	14.00	0.00	0.00	0.00	Nil
11	Bicarbonate Contents (mg/L)	119.00	106.00	122.00	120.00	284.00	122.00	106.00	235.00	139.00	120.00	168.80
12	Free Carbondioxide (mg/L)	5.28	0.00	5.28	7.04	0.00	5.28	0.00	12.50	1.76	2.80	4.70
13	Total Carbondioxid (mg/L)	751.00	130.90	751.00	950.00	305.00	751.00	107.20	3144.30	366.00	401.00	941.90
14	Dissolved Oxygen	8.20	8.50	8.20	8.30	6.50	8.50	8.80	6.90	7.10	8.50	9.60

TABLE "4"

PHYSICO - CHEMICAL CHARACTERSTICS OF TAP WATER FROM SAMPLING LOCATION'S A TO K DURING THE MONTH OF NOV. 1995

S.N.	PARAMETERS	SAMPLING LOCATION'S										
		A	B	C	D	E	F	G	H	I	J	K
1	Odour	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable	Earthy smell	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable
2	Taste	" "	" "	" "	" "	" "	" "	" "	Slight bitter	" "	" "	" "
3	Colour	Colorless	colorless	colorless	Colorless	Slight yellow	Colorless	Colorless	Slight yellow	Colorless	Colorless	Colorless
4	Temp (°C)	19° cg	20° cg	19°cg	19.5°cg	21° cg	20°cg	18° cg	19° cg	20° cg	20° cg	21.7°
5	Conductivity (Micromhos)	$2.2x10^2$	$2.35x10^2$	$2.55x10^2$	$2.3x10^2$	$6.1x10^2$	$2.8x10^2$	$2.4x10^2$	$6.1x10^2$	$2.9x10^2$	$2.2x10^2$	$2.7x10^2$
6	pH Value	7.50	7.40	7.50	7.55	7.00	7.60	7.60	7.00	7.50	7.50	8.20
7	Chloride Contents (mg/L)	30.00	26.00	28.00	31.00	24.00	30.00	19.00	44.00	29.50	20.00	21.50
8	Total Hardness(mg/L)	135.00	146.00	138.00	137.00	289.00	138.00	134.00	330.00	202.00	132.00	153.00
9	Total Alkalinity(mg/L)	130.00	128.00	122.00	120.00	390.00	129.00	126.00	240.00	132.00	128.00	178.00
10	Carbonate Contents (mg/L)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Nil
11	Bicarbonate Contents (mg/L)	130.00	128.00	122.00	120.00	390.00	129.00	126.00	240.00	132.00	128.00	178.00
12	Free Co_2 (mg/L)	4.40	2.60	5.28	7.04	10.80	3.50	2.90	13.20	17.60	2.60	7.40
13	Total Co_2 (mg/L)	686.40	445.40	751.00	950.00	4555.20	565.00	476.00	3379.00	2439.00	445.00	1829.80
14	Dissolved Oxygen (mg/L)	8.50	8.80	8.20	8.30	7.10	8.80	8.50	7.20	8.80	7.40	10.10

PHYSICO - CHEMICAL CHARACTERSTICS OF TAP WATER FROM SAMPLING LOCATION'S A TO K DURING THE MONTH OF DEC. 1995

S.N.	PARAMETERS	SAMPLING LOCATION'S										
		A	B	C	D	E	F	G	H	I	J	K
1	Odour	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable	Earthy Smell	Nonobject-ionable	Nonobject-ionable	Earthy Smell	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable
2	Taste	" "	" "	" "	" "	" "	" "	" "	" "	" "	" "	" "
3	Colour	Colorless	colorless	colorless	Colorless	Yellowish	Colorless	Colorless	Yellowish	Colorless	Colorless	Colorless
4	Temp (°C)	19° cg	19° cg	17°cg	18.1°cg	17.5° cg	18°cg	17° cg	20° cg	17.5° cg	18° cg	19.2°
5	Conductivity (Micromhos)	$2.35x10^2$	$2.5x10^2$	$2.5x10^2$	$2.55x10^2$	$5.6x10^2$	$2.3x10^2$	$2.4x10^2$	$5.9x10^2$	$2.9x10^2$	$2.4x10^2$	$2.7x10^2$
6	pH Value	7.80	7.50	7.45	7.45	7.10	7.50	7.60	7.10	7.60	7.60	7.50
7	Chloride Contents (mg/L)	22.00	23.00	29.90	30.00	25.00	24.00	20.00	45.00	29.90	30.00	21.20
8	Total Hardness(mg/L)	136.00	180.00	145.00	139.00	328.00	120.00	152.00	345.00	202.00	150.00	168.80
9	Total Alkalinity(mg/L)	142.00	140.00	122.00	118.00	401.00	124.00	146.00	245.00	132.00	140.00	198.00
10	Carbonate Contents (mg/L)	0.00	8.00	21.00	20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	Bicarbonate Contents (mg/L)	142.00	132.00	101.00	98.00	401.00	124.00	146.00	245.00	132.00	140.00	198.00
12	Free Co_2 (mg/L)	5.28	0.00	0.00	0.00	9.14	5.40	7.04	10.00	17.60	5.20	4.65
13	Total Co_2 (mg/L)	874.70	120.10	816.00	733.40	4008.00	778.00	1156.30	2665.60	2439.30	851.20	1094.90
14	Dissolved Oxygen (mg/L)	8.80	8.90	8.70	8.80	7.50	8.80	8.70	7.20	8.80	8.80	9.30

PHYSICO - CHEMICAL CHARACTERSTICS OF TAP WATER FROM SAMPLING LOCATION'S A TO K DURING THE MONTH OF JAN. 1996

S.N.	PARAMETERS	SAMPLING LOCATION'S										
		A	B	C	D	E	F	G	H	I	J	K
1	Odour	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable	Earthy Smell	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable
2	Taste	" "	" "	" "	" "	Bitter	" "	" "	" "	" "	" "	" "
3	Colour	Colorless	colorless	colorless	Colorless	Light yellow	" "	" "	" "	Colorless	" "	Colorless
4	Temp (°C)	14° cg	15° cg	14°cg	14°cg	16° cg	15°cg	14° cg	15° cg	15° cg	16° cg	17.0°
5	Conductivity (Micromhos)	$2.5x10^2$	$2.6x10^2$	$2.7x10^2$	$2.6x10^2$	$6.2x10^2$	$2.5x10^2$	$2.35x10^2$	$6.5x10^2$	$2.9x10^2$	$2.8x10^2$	$2.84x10^2$
6	pH Value	7.50	7.40	7.50	7.50	6.99	7.50	7.40	7.20	7.50	7.50	7.65
7	Chloride Contents (mg/L)	30.00	35.00	40.00	40.00	61.00	35.00	25.00	60.10	35.00	29.00	27.00
8	Total Hardness(mg/L)	145.00	160.00	150.00	149.00	355.00	125.00	152.00	320.00	196.00	155.00	155.60
9	Total Alkalinity(mg/L)	115.00	140.00	135.00	139.00	290.00	135.00	139.00	240.00	129.00	145.00	184.10
10	Carbonate Contents (mg/L)	0.00	8.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	Bicarbonate Contents (mg/L)	115.00	140.00	135.00	139.00	290.00	135.00	139.00	240.00	129.00	155.00	184.10
12	Free Co_2 (mg/L)	5.26	6.20	7.50	7.20	13.50	2.50	5.28	12.20	5.20	7.20	8.50
13	Total Co_2 (mg/L)	706.10	991.00	1131.30	1123.00	4170.00	456.30	856.00	3139.20	784.30	1252.40	1725.90
14	Dissolved Oxygen (mg/L)	8.90	8.80	8.50	8.50	7.50	8.90	8.80	7.20	8.90	9.00	9.35

PHYSICO - CHEMICAL CHARACTERSTICS OF TAP WATER FROM SAMPLING LOCATION'S A TO K DURING THE MONTH OF FEB. 1996

S.N.	PARAMETERS	SAMPLING LOCATION'S										
		A	B	C	D	E	F	G	H	I	J	K
1	Odour	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable	Objection-able smell	Unobject-ionable	Unobject-ionable	Objection-able smell	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable
2	Taste	" "	" "	" "	" "	Taste	" "	" "	Taste	" "	" "	" "
3	Colour	Colorless	colorless	colorless	Colorless	Yellowish	Clear	Clear	Yellowish	Clear	Colorless	Colorless
4	Temp (°C)	20.5° cg	21° cg	19°cg	19°cg	21° cg	22°cg	20.5° cg	21° cg	20° cg	21° cg	18.3°
5	Conductivity (Micromhos)	$2.5x10^2$	$2.1x10^2$	$2.5x10^2$	$2.1x10^2$	$5.9x10^2$	$2.1x10^2$	$2.5x10^2$	$6.2x10^2$	$2.5x10^2$	$2.4x10^2$	$2.69x10^2$
6	pH Value	7.50	7.50	7.30	7.30	7.00	7.50	7.40	6.90	7.50	7.40	7.60
7	Chloride Contents (mg/L)	38.00	38.00	35.00	39.00	38.00	40.20	44.00	49.00	43.00	45.00	28.50
8	Total Hardness(mg/L)	114.00	160.00	104.00	112.00	390.00	150.00	105.00	300.00	110.00	115.00	152.00
9	Total Alkalinity(mg/L)	99.00	138.00	102.00	98.00	215.00	119.00	115.00	200.00	126.00	142.00	180.20
10	Carbonate Contents (mg/L)	13.00	16.00	16.00	16.00	0.00	0.00	0.00	16.00	12.00	16.00	0.00
11	Bicarbonate Contents (mg/L)	86.00	122.00	86.00	82.00	215.00	119.00	115.00	184.00	114.00	126.00	180.20
12	Free Co_2 (mg/L)	0.00	0.00	0.00	0.00	12.00	2.50	2.90	0.00	0.00	0.00	7.89
13	Total Co_2 (mg/L)	91.60	123.30	91.00	670.30	2769.20	402.20	434.70	177.90	112.30	126.80	1578.60
14	Dissolved Oxygen (mg/L)	9.00	9.10	9.10	9.20	8.00	9.00	8.90	8.80	8.70	8.90	9.95

TABLE - 8

PHYSICOCHEMICAL CHARACTERSTICS OF TAP WATER AT 11 SAMPLING LOCATIONS DURING THE MONTH OF MARCH 1996

SN.	PARAMETERS	NAME OF THE SAMPLING LOCATIONS										
		A	B	C	D	E	F	G	H	I	J	K
1	ODOUR	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable	Earthy & musty smell	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable	Earthy & musty smell	Nonobject-ionable	Earthy & musty smell
2.	TASTE	"	"	"	"	Slight-bitter	"	"	"	Slight-bitter	"	Slight-bitter
3.	COLOUR	Colourless	Colourless	Colourless	Colourless	Slight-yellowish	Colourless	Colourless	Colourless	Slight-yellowish	Colourless	Slight-yellowish
4.	TEMPERATURE (°C)	30° C	28° C	24° C	24° C	24° C	26° C	26° C	26° C	26° C	26° C	29.6° C
5.	ELECTRICAL CONDUCTIVITY (MICROMHOS)	$3.6X10^2$	$3.7X10^2$	$3.3X10^2$	$3.7X10^3$	$6.2X10^3$	$3.9X10^3$	$3.5X10^3$	$3.7X10^3$	$3.7X10^3$	$4.8X10^3$	$3.57X10^2$
6.	pH VALUE	7.6	7.5	7.5	7.4	7.8	7.6	7.6	7.7	7.5	7.4	8.1
7.	CHLORIDE CONTENTS(Mg/ L)	40	42	52.2	50.2	60	34.2	39	42	62	48	20.7
8.	TOTAL HARDNESS (Mg/ L)	190	120	125	138	395	140	148	309	400	185	195
9.	TOTAL ALKALINITY(Mg/ L)	98	110	115	136	250	150	119	148	300	165	233
10	CARBONATE CONTENTS(Mg/ L)	0.0	0.0	10.1	0.0	0.0	29.9	0.0	0.0	0.0	0.0	0.0
11.	BICARBONATE CONTENTS(Mg/ L)	98	110	105	136	250	120	119	148	300	165	233
12.	FREE CARBONDIOXIDE (Mg/L)	3.0	2.0	0.0	4.0	8.0	0.0	1.0	3.0	9.0	4.0	8.4
13.	TOTAL CARBONDIOXIDE (Mg/L)	380	316.8	97.45	663.6	2220.0	120.0	223.7	574.2	2964.0	805.2	2162.2
14.	DISSOLVED OXYGEN (Mg/L)	7.5	6.8	6.9	6.1	4.9	6.2	6.6	6.5	6.6	6.9	7.1
15.	BIOLOGICALY OXYGEN DEMAND (Mg/L)	1.2	1.0	1.1	0.9	2.1	1.01	1.2	0.95	2.0	1.1	1.80

TABLE - 9

PHYSICOCHEMICAL CHARACTERSTICS OF TAP WATER AT 11 SAMPLING LOCATIONS DURING THE MONTH OF APRIL 1996

SN.	PARAMETERS	NAME OF THE SAMPLING LOCATIONS										
		A	B	C	D	E	F	G	H	I	J	K
1	ODOUR	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable	Earthy & musty smell	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable	Earthy & musty smell	Nonobject-ionable	Earthy smell
2.	TASTE	"	"	"	"	Slight-bitter	"	"	"	Slight-bitter	"	Unplaesentaste
3.	COLOUR	Colourless	Colourless	Colourless	Colourless	Slight-yellowish	Colourless	Colourless	Colourless	Slight-yellowish	Colourless	yellowish green
4.	TEMPERATURE (°C)	34° C	36° C	36° C	34° C	32° C	35° C	33° C	35° C	32° C	34° C	33.1° C
5.	ELECTRICAL CONDUCTIVITY (MICROMHOS)	$3.6X10^3$	$3.2X10^3$	$2.6X10^3$	$2.8X10^3$	$6.9X10^3$	$3.5X10^3$	$2.9X10^3$	$3.5X10^3$	$4.2X10^3$	$4.6X10^3$	$5.2X10^2$
6.	pH VALUE	7.2	7.2	7.3	7.3	7.3	7.5	7.6	7.6	7.5	7.8	8.3
7.	CHLORIDE CONTENTS(Mg/ L)	29.8	30.0	32.0	35.0	60.0	39.9	40.0	42.0	52.1	42.2	44.1
8.	TOTAL HARDNESS (Mg/ L)	188.8	150.0	155.0	140.9	389.9	190.9	185.0	290.9	395.0	198.8	215.6
9.	TOTAL ALKALINITY(Mg/ L)	155.0	140.0	168.9	135.0	300.0	190.0	185.9	280.0	345.0	160.6	239.0
10	CARBONATE CONTENTS(Mg/ L)	16.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11.	BICARBONATE CONTENTS(Mg/ L)	139.0	140.0	168.9	135.0	300.0	190.0	185.9	280.0	345.0	160.6	239.0
12.	FREE CARBONDIOXIDE (Mg/L)	0.0	4.0	6.0	2.0	14.0	6.0	7.0	12.0	13.0	2.0	10.1
13.	TOTAL CARBONDIOXIDE (Mg/L)	138.7	683.2	1162.0	388.8	4464.0	1307.2	1464.8	3606.4	4788.6	460.8	2637.3
14.	DISSOLVED OXYGEN (Mg/L)	7.0	7.5	6.9	6.8	5.99	6.9	7.0	6.1	6.2	7.0	7.15
15.	BIOLOGICALY OXYGEN DEMAND (Mg/L)	1.0	0.9	0.99	0.85	2.2	1.2	1.24	1.2	2.05	2.0	1.96

TABLE - 10

PHYSICOCHEMICAL CHARACTERSTICS OF TAP WATER AT 11 SAMPLING LOCATIONS DURING THE MONTH OF MAY 1996

SN.	PARAMETERS	NAME OF THE SAMPLING LOCATIONS										
		A	B	C	D	E	F	G	H	I	J	K
1	ODOUR	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable	Earthy & musty smell	Object-ionablesmell	Nonobject-ionable	Earthy & musty smell	Earthy & musty smell	Nonobject-ionable	Earthy smell
2.	TASTE	"	"	"	"	unplaesent taste	Slight-bitter	"	"	Slight-bitter	"	unplaesent taste
3.	COLOUR	Colourless	Colourless	Colourless	Colourless	Slight-yellowish	Slight-yellowish	Colourless	yellowish	Slight-yellowish	Colourless	Greenish
4.	TEMPERATURE (°C)	38° C	38° C	38° C	38° C	38° C	39° C	39.2° C	38° C	38° C	38° C	34.6° C
5.	ELECTRICAL CONDUCTIVITY (MICROMHOS)	$3.8X10^3$	$3.9X10^3$	$3.3X10^3$	$3.4X10^3$	$6.1X10^3$	$3.9X10^3$	$3.8X10^3$	$3.9X10^3$	$5.9X10^3$	$3.1X10^3$	$7.3X10^2$
6.	pH VALUE	7.54	7.6	7.54	7.5	7.82	7.45	7.6	7.5	7.9	7.8	8.6
7.	CHLORIDE CONTENTS(Mg/ L)	42.2	49.9	59.9	60.1	109.2	70.0	49.9	82.2	102.1	65.5	46.7
8.	TOTAL HARDNESS (Mg/ L)	190.2	129.9	140.0	135.0	402.0	160.5	180.5	285.0	399.4	200.2	221.5
9.	TOTAL ALKALINITY(Mg/ L)	200.0	120.2	135.0	148.0	390.9	168.2	139.9	200.0	400.0	180.5	251.0
10	CARBONATE CONTENTS(Mg/ L)	0.0	0.0	0.0	14.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11.	BICARBONATE CONTENTS(Mg/ L)	200.0	120.2	135.0	133.9	390.9	168.2	139.9	200.0	400.0	180.5	251.0
12.	FREE CARBONDIOXIDE (Mg/L)	8.8	7.04	5.28	0.0	15.84	3.52	7.04	1.76	17.6	5.28	9.7
13.	TOTAL CARBONDIOXIDE (Mg/L)	1936.0	950.4	831.6	132.3	6520.8	740.08	1108.0	528.0	7395.6	1108.8	2655.5
14.	DISSOLVED OXYGEN (Mg/L)	7.2	7.0	7.1	6.8	5.2	6.2	6.1	6.0	5.9	6.0	6.1
15.	BIOLOGICALY OXYGEN DEMAND (Mg/L)	1.2	1.3	1.2	0.99	2.89	1.0	1.4	0.8	2.4	1.5	1.84

TABLE - 11

PHYSICOCHEMICAL CHARACTERSTICS OF TAP WATER AT 11 SAMPLING LOCATIONS DURING THE MONTH OF JUNE 1996

SN.	PARAMETERS	NAME OF THE SAMPLING LOCATIONS										
		A	B	C	D	E	F	G	H	I	J	K
1	ODOUR	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable	Earthy & musty smell	Nonobject-ionable	Nonobject-ionable	Earthy & musty smell	Earthy & musty smell	Earthy & musty smell	Earthy smell
2.	TASTE	"	"	"	"	Unplaesent taste	"	"	Unplaesent taste	Unplaesent taste	Bitter	Unplaesentaste
3.	COLOUR	Colourless	Colourless	Colourless	Colourless	Slight-yellowish	Colourless	Colourless	Colourless	Slight-yellowish	Slight-yellowish	yellowish green
4.	TEMPERATURE (°C)	39° C	39° C	39° C	38° C	38° C	40° C	39.2° C	39.1° C	38.9° C	40° C	28.6° C
5.	ELECTRICAL CONDUCTIVITY (MICROMHOS)	$4.2X10^3$	$5.1X10^3$	$3.9X10^3$	$3.4X10^3$	$6.4X10^3$	$3.2X10^3$	$3.4X10^3$	$6.0X10^3$	$6.8X10^3$	$5.9X10^3$	$3.9X10^2$
6.	pH VALUE	7.6	7.7	7.7	7.8	7.8	7.7	7.6	7.9	7.9	7.8	8.2
7.	CHLORIDE CONTENTS(Mg/ L)	45.2	60.2	62.5	70.5	99.9	39.2	38.5	92.9	120.2	85.1	29.5
8.	TOTAL HARDNESS (Mg/ L)	180.1	159.2	170.2	164.2	409.2	180.2	160.2	190.9	420.9	198.8	214.2
9.	TOTAL ALKALINITY(Mg/ L)	180.1	149.2	180.1	168.2	430.3	200.2	140.1	200.2	390.2	192.8	198.5
10	CARBONATE CONTENTS(Mg/ L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11.	BICARBONATE CONTENTS(Mg/ L)	180.1	149.2	180.1	168.2	430.3	200.2	140.1	200.2	390.2	192.8	198.5
12.	FREE CARBONDIOXIDE (Mg/L)	7.04	3.52	7.04	10.56	14.08	10.5	7.2	13.2	31.6	12.32	5.8
13.	TOTAL CARBONDIOXIDE (Mg/L)	1108.8	656.4	1425.6	1924.2	6432.8	2276.0	1131.2	2816.0	12667.2	2524.4	1525.9
14.	DISSOLVED OXYGEN (Mg/L)	6.0	6.2	6.9	6.8	4.0	6.9	6.8	5.9	5.5	6.0	8.9
15.	BIOLOGICALY OXYGEN DEMAND (Mg/L)	1.1	1.1	1.12	1.8	2.5	1.3	1.3	1.8	2.4	2.0	1.5

TABLE - 12

PHYSICOCHEMICAL CHARACTERSTICS OF TAP WATER AT 11 SAMPLING LOCATIONS DURING THE MONTH OF JULY 1996

SN.	PARAMETERS	NAME OF THE SAMPLING LOCATIONS										
		A	B	C	D	E	F	G	H	I	J	K
1	ODOUR	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable	Earthy & musty smell	Nonobject-ionable	Nonobject-ionable	Earthy & musty smell	Earthy & musty smell	Object-ionable smell	Earthy smell
2.	TASTE	"	"	"	"	unplaesent taste	"	"	unplaesent taste	Slight-bitter	Slight-bitter	unplaesent taste
3.	COLOUR	Colourless	Colourless	Colourless	Colourless	Slight-muddy	Colourless	Colourless	yellowish	Slight-yellowish	Slight-yellowish	Greenish Yellow
4.	TEMPERATURE (°C)	32° C	32° C	33° C	32° C	32° C	33° C	32° C	32° C	32° C	32° C	27° C
5.	ELECTRICAL CONDUCTIVITY (MICROMHOS)	$2.9X10^2$	$2.8X10^2$	$2.82X10^2$	$2.77X10^2$	$7.2X10^3$	$2.6X10^2$	$2.65X10^2$	$2.7X10^2$	$8.9X10^2$	$2.6X10^2$	$2.9X10^2$
6.	pH VALUE	7.2	7.2	7.21	7.3	7.8	7.3	7.4	7.4	7.7	7.4	8.25
7.	CHLORIDE CONTENTS(Mg/ L)	32.1	45.5	38.2	39.9	60.2	31.0	29.0	29.1	68.2	28.2	26.5
8.	TOTAL HARDNESS (Mg/ L)	120.0	129.2	140.2	155.1	250.5	140.2	150.2	289.2	500.0	160.6	173.8
9.	TOTAL ALKALINITY(Mg/ L)	135.0	130.2	120.9	140.2	260.0	120.2	159.2	270.9	289.0	145.0	198.2
10	CARBONATE CONTENTS(Mg/ L)	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.0	0.0
11.	BICARBONATE CONTENTS(Mg/ L)	115.8	130.2	120.9	140.2	260.0	120.2	159.2	270.0	289.0	130.2	189.2
12.	FREE CARBONDIOXIDE (Mg/L)	0.0	5.28	5.28	7.04	9.0	1.76	2.8	12.5	12.5	0.0	4.2
13.	TOTAL CARBONDIOXIDE (Mg/L)	121.2	800.8	739.2	1108.8	2568.8	316.8	585.8	3624.6	2866.8	130.5	1006.8
14.	DISSOLVED OXYGEN (Mg/L)	7.5	7.6	7.9	8.0	7.5	7.5	7.9	8.2	8.5	8.3	6.7
15.	BIOLOGICALY OXYGEN DEMAND (Mg/L)	1.2	0.9	0.92	0.89	1.8	1.3	1.2	1.8	1.9	1.01	1.6

TABLE - 13

PHYSICOCHEMICAL CHARACTERSTICS OF TAP WATER AT 11 SAMPLING LOCATIONS DURING THE MONTH OF AUGUST 1996

SN.	PARAMETERS	NAME OF THE SAMPLING LOCATIONS										
		A	B	C	D	E	F	G	H	I	J	K
1	ODOUR	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable	Earthy & musty smell	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable	Earthy & musty smell	Nonobject-ionable	Earthy smell
2.	TASTE	"	"	"	"	Unplaesent taste	"	"	"	Unplaesent taste	"	Unplaesentaste
3.	COLOUR	Colourless	Colourless	Colourless	Colourless	Slight-yellowish	Colourless	Slight-yellowish	Colourless	Muddy water	Colourless	yellowish green
4.	TEMPERATURE (°C)	30° C	29.2° C	30° C	30° C	29° C	28° C	28° C	29° C	28° C	28° C	24° C
5.	ELECTRICAL CONDUCTIVITY (MICROMHOS)	$2.1X10^2$	$2.0X10^2$	$2.2X10^2$	$2.4X10^2$	$5.9X10^2$	$2.21X10^2$	$1.90X10^2$	$2.4X10^2$	$5.8X10^2$	$2.4X10^2$	$2.32X10^2$
6.	pH VALUE	7.3	7.3	7.7	7.4	7.7	7.3	7.4	7.8	7.8	7.3	7.7
7.	CHLORIDE CONTENTS(Mg/ L)	25.0	29.0	30.0	28.0	50.0	25.0	24.0	29.0	58.0	29.0	20.0
8.	TOTAL HARDNESS (Mg/ L)	129.2	160.2	162.2	150.0	350.0	170.0	140.0	148.0	308.0	259.2	120.0
9.	TOTAL ALKALINITY(Mg/ L)	120.1	161.2	156.6	145.0	280.8	171.1	133.7	170.7	325.3	200.0	148.0
10	CARBONATE CONTENTS(Mg/ L)	24.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11.	BICARBONATE CONTENTS(Mg/ L)	96.5	157.9	156.6	145.0	280.8	171.1	133.7	170.7	325.3	200.0	148.0
12.	FREE CARBONDIOXIDE (Mg/L)	0.0	0.0	1.75	7.04	7.04	5.28	2.8	1.76	5.28	3.04	0.0
13.	TOTAL CARBONDIOXIDE (Mg/L)	108.9	142.9	411.8	1148.4	2223.9	1053.9	492.0	450.6	2003.8	784.0	1091.2
14.	DISSOLVED OXYGEN (Mg/L)	7.5	7.0	7.8	7.8	8.0	7.0	7.5	7.5	8.2	8.1	8.6
15.	BIOLOGICALY OXYGEN DEMAND (Mg/L)	1.2	1.3	1.21	1.4	2.1	1.4	1.01	1.08	1.93	1.0	2.2

2. **Taste** - During the present investigation's it has been found that water supply of Jhansi was satisfactory in taste except during summer months, when it was having bitter taste specially at some sampling location's. At the sampling location's A,B,C,D water was unobjectionable during the whole year but at the sampling location 'E' water was bitter in taste in the month of April & June. At sampling location 'F' it had bitter taste in the month of May. At sampling location 'G' water was unobjectionable during the whole year. At sampleing location 'I' water was bitter in taste in April,May,June and July months. Sampling location's H & J showed bitter taste in June and July months.

From above investigation's it is clear that in winter season water was unobjectionable but at the above mentioned sampling location's water was bitter in taste in summer and rainy season's.

3. **Colour** - During the present study it was found that at sampling location's A, B, C, D water was colourless during the whole year. Where as sampling location 'E' showed slight turbidity with yellowishing in the month's of November, January, 95, April, June, July and August 96. Sampling location 'F' showed slight yellowish colour in the month of May. At sampling location 'G' water was slight yellowish in the month of August. Sampling section 'H' showed yellowish colour in the months of October, November, February., June, July and August.

At sampling location 'I' water was also yellowish in October, March, Aapril, May, June, July and August. Sampling location 'J' showed slight turbidity in the month's of June and July.

From above it is clear that sampling location's A, B, C, & D had colourless water supply while at sampling location's E, H & I had yellowish colour water during 5 month's of the year and at sampling location's F, G & J had yellowish colour water supply for one or two months. Yellowish colour of water at the above mentioned station's was mainly during summer and or rainy season.

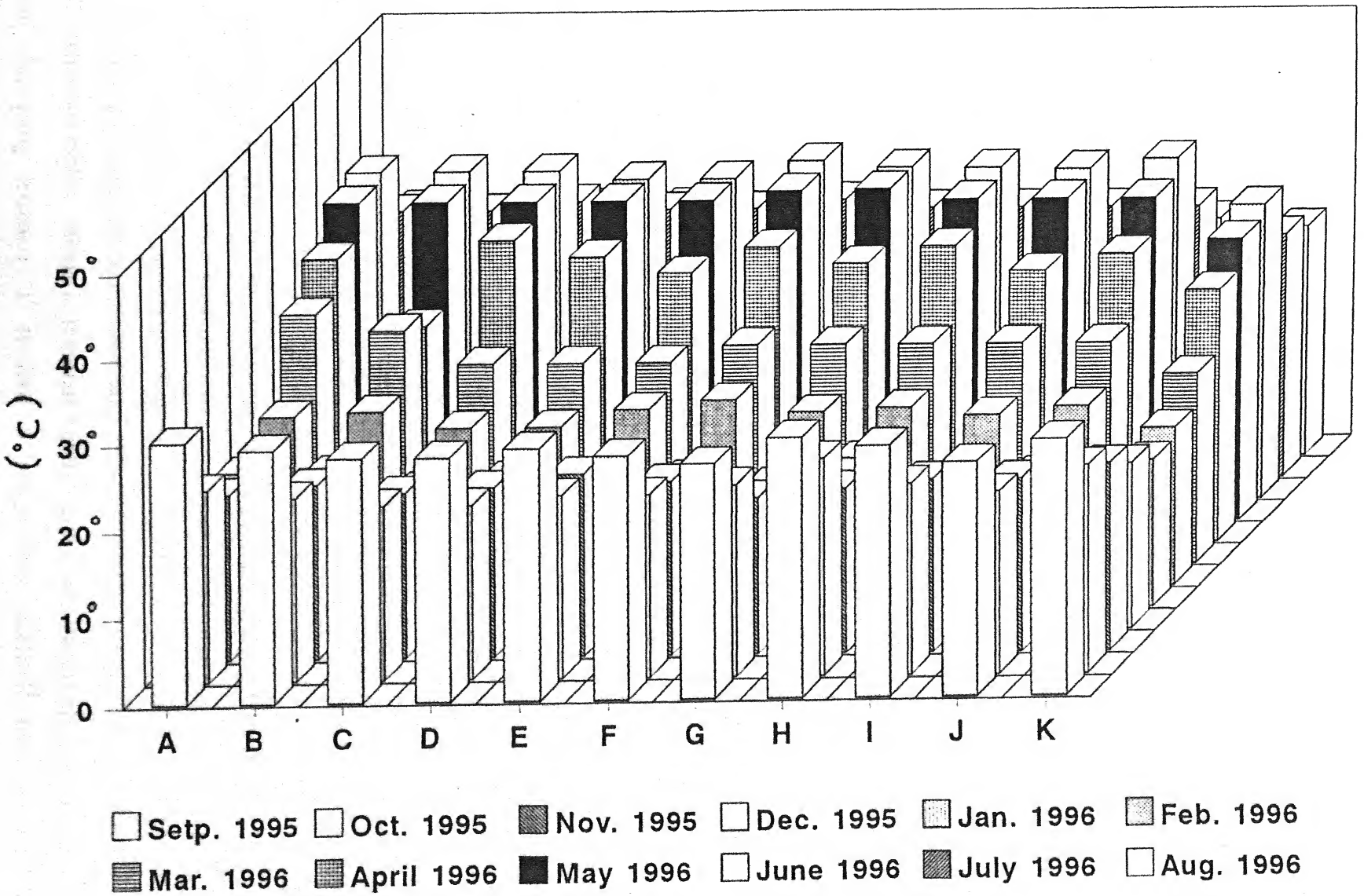
4. Temperature (°C) - During the period of study maximum water temperature of 40° C. was recorded in the month of June 96 at sampling location's 'F' & 'J' while minimum temperature of 14°C. was observed in the month of January 96, at the sampling location's A, C, D & G (Table - 14 and Histogram 14A). Variation's were observed during September 1995 to August 1996.

TABLE - 14

MONTHLY VARIATION'S IN TEMPERATURE (C) OF TAP WATER SUPPLY OF JHANSI AT DIFFERENT SAMPLING LOCATIONS DURING THE STUDY PERIOD

S.N.	MONTH'S/YEAR	SAMPLING STATION'S										
		A	B	C	D	E	F	G	H	I	J	K
1	SEPT. 1995	30°	29°	28°	28°	29°	28°	27°	30°	29°	27°	29.6°
2	OCT. 95	22°	21°	20°	20°	21°	21°	22°	25°	22°	21°	24°
3	NOV. 95	19°	20°	19°	19.5°	21°	20°	18°	19°	20°	20°	21.7°
4	DEC. 95	19°	19°	17°	18.1°	17.5°	18°	17°	20°	17.5°	18°	19.2°
5	JAN. 1996	14°	15°	14°	14°	16°	15°	14°	15°	15°	18°	17.0°
6	FEB. 96	20.5°	21°	19°	19°	21°	22°	20.5°	21°	20°	21°	18.3°
7	MAR. 96	30°	28°	24°	24°	24°	26°	26°	26°	26°	26°	22.2°
8	APR. 96	34°	26°	36°	34°	32°	35°	33°	35°	32°	34°	29.6°
9	MAY 96	38°	38°	38°	38°	38°	39°	39.2°	38°	38°	38°	33.1°
10	JUN. 96	39°	39°	39°	38°	38°	40°	39.2°	39.1°	38.9°	40°	34.6°
11	JUL. 96	32°	32°	33°	32°	32°	33°	32°	32°	32°	32°	28.6°
12	AUG. 96	30°	29.2°	30°	30°	29°	28°	28°	29°	28°	28°	27°

MONTHLY VARIATION OF TEMPERATURE AT 11 SAMPLING LOCATIONS



In general, at all sampling location's water temperature during January was lowest and highest during June. After June, the temperature gradually decreased throughout the rainy and winter season approaching minimum value in January Then it again gradually increased during February., March, April, May and ultimately reached it maximum value during June.

5. Electrical Conductivity (Micromhos) : Analytical data's for electrical conductivity of tap water showed seasonal variation ranging between $2.0X10^2$ to $7.2X10^3$ micromhos. Maximum value was observed in the month of July at sampling location 'E' and minimum value was observed in August at sampling location 'B', (Table '15' and Histogram 15A).

At sampling location 'A' maximum value was $4.2X10^3$ micromhos in the month of June and minimum value was $2.1X10^2$ micromhos in August. Sampling location 'B' showed highest value of $5.1X10^3$ micromhos in the month of June and lowest value of $2.0X10^2$ micromhos during August. Sampling location 'C' showed maximum value of $3.9X10^3$ micromhos in the month of June and minimum value of $2.2X10^2$ micromhos in the month of August. At sampling location 'D' maximum value recorded was $3.7X10^3$ micromhos during March and minimum value of $2.1X10^2$ micromhos was recorded in the month of February. (table 15). At sampling location 'E' the values of electrical conductivity showed highest range from $5.6X10^2$ to $7.2X10^3$ micromhos. Maximum value was observed in July and minimum value's were found during September. and December.

At sampling location 'F' electrical conductivity varied from $2.1X\ 10^2$ to $3.9\ X\ 10^3$. Maximum value in the months of March and May and maximum value during February 96. At sampling location 'G' maximum value was $3.8X10^3$ micromhos, in the month of May and minimum value of $1.90X10^2$ micromhos, was found in August 96.

Sampling location 'H' showed wide range between $2.4X10^2$ to $6.0X\ 10^3$ micromhos. Maximum value was observed in January and minimum value was observed in August. At sampling location 'I' maximum value was $6.8X10^3$ micromhos in June and minimum value was $2.5X10^2$ micromhos in February. This location showed higher values in summer months and lower values during winter months. Sampling location 'J' showed a range from $2.2X10^2$ to $6.3X10^3$

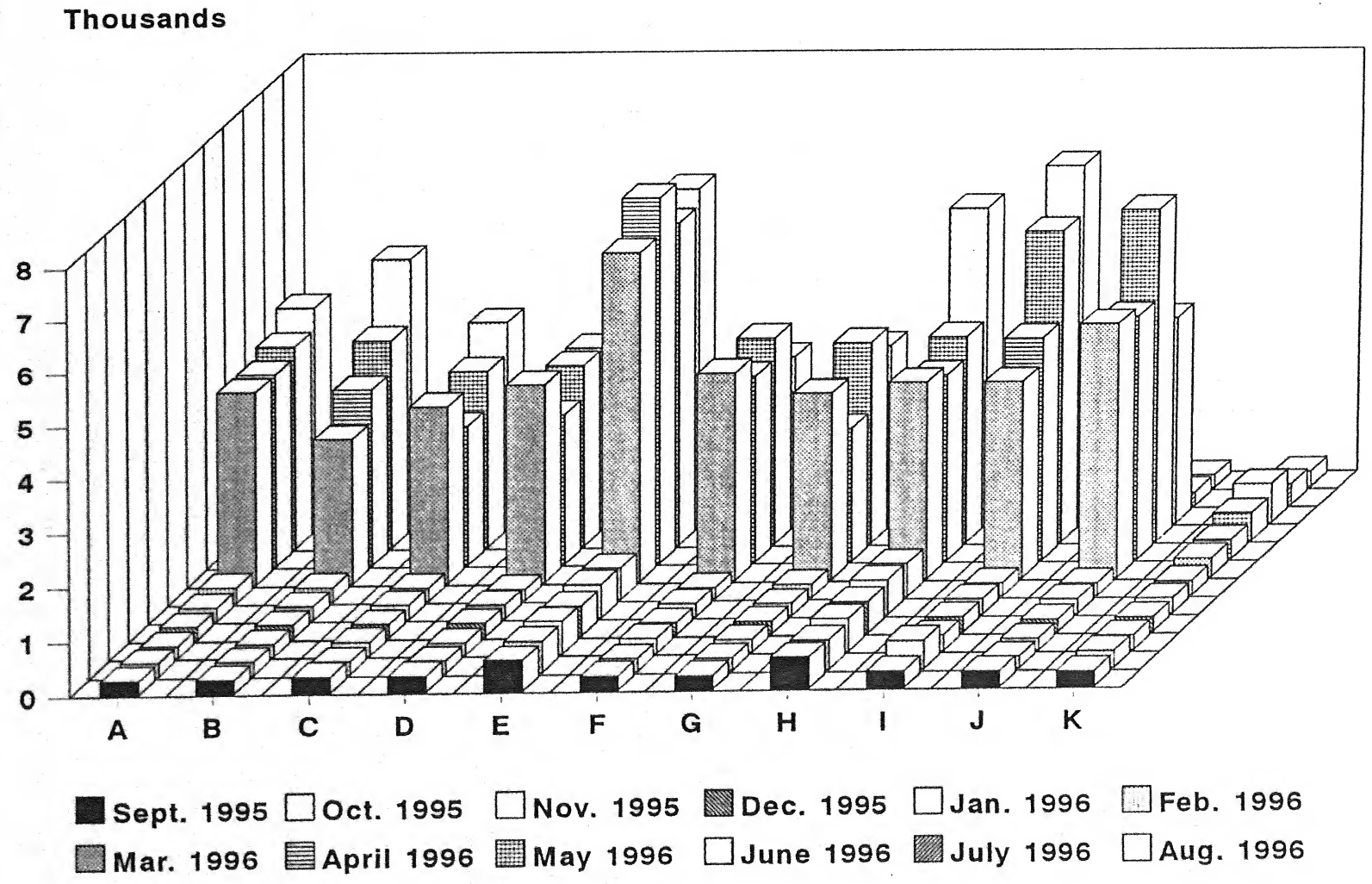
TABLE - 15

MONTHLY VARIATION'S IN ELECTRICAL CONDUCTIVITY (MICRO MHOS) OF TAP WATER SUPPLY AT DIFFERENT SAMPLING LOCATION'S DURING THE STUDY PERIOD

S.N.	MONTH'S/YEAR	SAMPLING LOCATION'S										
		A	B	C	D	E	F	G	H	I	J	K
1	SEPT. 1995	$2.5x10^2$	$2.5x10^2$	$2.9x10^2$	$2.9x10^2$	$5.6x10^2$	$2.6x10^2$	$2.6x10^2$	$5.7x10^2$	$3.0x10^2$	$2.9x10^2$	$2.8x10^2$
2	OCT. 95	$2.4x10^2$	$2.45x10^2$	$2.3x10^2$	$2.3x10^2$	$5.8x10^2$	$2.4x10^2$	$2.35x10^2$	$5.5x10^2$	$5.3x10^2$	$2.2x10^2$	$3.2x10^2$
3	NOV. 95	$2.2x10^2$	$2.35x10^2$	$2.55x10^2$	$2.3x10^2$	$6.1x10^2$	$2.8x10^2$	$2.4x10^2$	$6.1x10^2$	$2.9x10^2$	$2.2x10^2$	$2.7x10^2$
4	DEC. 95	$2.35x10^2$	$2.5x10^2$	$2.5x10^2$	$2.55x10^2$	$5.6x10^2$	$2.3x10^2$	$2.4x10^2$	$5.9x10^2$	$2.9x10^2$	$2.4x10^2$	$2.7x10^2$
5	JAN. 1996	$2.52x10^2$	$2.6x10^2$	$2.7x10^2$	$2.6x10^2$	$6.2x10^2$	$2.5x10^2$	$2.35x10^2$	$6.5x10^2$	$2.9x10^2$	$2.8x10^2$	$2.84x10^2$
6	FEB. 96	$2.9x10^2$	$2.7x10^2$	$2.5x10^2$	$2.1x10^2$	$5.9x10^2$	$2.1x10^2$	$2.5x10^2$	$6.2x10^2$	$2.5x10^2$	$2.4x10^2$	$2.69x10^2$
7	MAR. 96	$3.6x10^3$	$3.7x10^3$	$3.3x10^3$	$3.7x10^3$	$6.2x10^3$	$3.9x10^3$	$3.5x10^3$	$3.7x10^3$	$3.7x10^3$	$4.8x10^2$	$3.5x10^2$
8	APR. 96	$3.6x10^3$	$3.3x10^3$	$2.6x10^3$	$2.8x10^3$	$6.9x10^3$	$3.5x10^3$	$2.5x10^3$	$3.5x10^3$	$4.2x10^3$	$4.6x10^3$	$3.57x10^2$
9	MAY 96	$3.8x10^3$	$3.9x10^3$	$3.3x10^3$	$3.4x10^3$	$6.1x10^3$	$3.9x10^3$	$3.8x10^3$	$3.9x10^3$	$5.9x10^3$	$6.3x10^3$	$5.2x10^2$
10	JUN. 96	$4.2x10^3$	$5.1x10^3$	$3.9x10^3$	$3.4x10^3$	$6.4x10^3$	$3.2x10^3$	$3.4x10^3$	6.0x103	$6.8x10^3$	$5.9x10^3$	$7.3x10^2$
11	JUL. 96	$2.9x10^2$	$2.8x10^2$	$2.82x10^2$	$2.77x10^2$	$7.2x10^3$	$2.6x10^2$	$2.65x10^2$	$2.7x10^2$	$8.9x10^2$	$2.6x10^2$	$3.9x10^2$
12	AUG. 96	$2.1x10^2$	$2.0x10^2$	$2.2x10^2$	$2.4x10^2$	$5.9x10^2$	$2.21x10^2$	$1.90x10^2$	$2.4x10^2$	$5.8x10^2$	$2.4x10^2$	$2.9x10^2$

Histogram - 15 A

MONTHLY VARIATIONS OF ELECTRICAL CONDUCTIVITY (Micromhos) AT 11 SAMPLING LOCATIONS



micromhos where, maximum values were recorded in June and minimum values in October and November.

In general, higher values were recorded in summer months at all sampling location's.

6. pH Value : The seasonal variation's in hydrogen ion concentration of tap water supply of Jhansi ranged between 6.89 to 8.0. Minimum value of 6.89 was observed in September. at location 'H' and maximum value 8.0 was observed in the month of June at the sampling location 'E' & 'H' (TABLE - 16 and Histogram16A).

At the sampling location 'A', B, C, D, F, G, I & J, pH value showed very narrow range between 7.1 to 7.9. Sampling location 'E' & 'H' showed wide range i.e. at location 'E' the pH value's ranged from 6.09 (September) to 8.0 (June). At location 'H' pH ranged from 6.09 to 8.0 (During the same months).

In general, at all sampling location's pH changes were very small.

7. Chloride Content's : During the present investigation chloride content's of tap water of Jhansi showed high range between 16.9 mg/L to 133.0 mg/L. Minimum value was observed in September from sampling location 'G' and maximum value was observed in September. at sampling location 'I'. (Table-17 and Histogram17A)

At sampling location 'A' minimum and maximum values recorded were 22.0 mg/L (September. 95) to 45.2 mg/L (in June 96) respectively. Values were less in winter and rainy season. After summer (June) it decreased throughout rainy season. At sampling location 'B' chloride contents ranged between 20.5 mg/L to 60.2 mg/L. Minimum value of 20.5 mg/L in September 95 and maximum value of 60.2 mg/L it was in June. At sampling location 'C' minimum and maximum values ranged between 28.0 mg/L (November) to 62.5 mg/L (June). Sampling location 'D' showed comparatively wide ranged between 28.0 mg/L to 70.5 mg/L. Minimum value observed in September. and maximum value in June.

At sampling location 'E' showed wide variation range is between 24.0 mg/L 109.2 mg/L. Minimum value was observed in October and November and maximum value in May 96.

TABLE - 16

MONTHLY VARIATION'S IN pH VALUE OF TAP WATER SUPPLY AT DIFFERENT SAMPLING LOCATION'S DURING THE STUDY PERIOD

S.N.	MONTH'S/YEAR	SAMPLING LOCATION'S										
		A	B	C	D	E	F	G	H	I	J	K
1	SEPT. 1995	7.5	7.4	7.8	7.7	6.95	7.5	7.5	6.89	7.8	7.5	8
2	OCT. 95	7.4	7.5	7.4	7.4	7.09	7.45	7.35	6.9	7.1	7.5	7.9
3	NOV. 95	7.5	7.4	7.5	7.55	7.08	7.6	7.6	7	7.5	7.5	8.2
4	DEC. 95	7.8	7.5	7.45	7.45	7.1	7.5	7.6	7.1	7.6	7.6	7.5
5	JAN. 1996	7.5	7.4	7.5	7.5	6.99	7	7	7.2	7.2	7.4	7.65
6	FEB. 96	7.1	7.5	7.3	7.3	7.01	7.5	7.4	6.9	7.5	7.4	7.6
7	MAR. 96	7.6	7.5	7.5	7.4	7.8	7.6	7.6	7.7	7.5	7.4	7.83
8	APR. 96	7.2	7.2	7.3	7.3	7.3	7.5	7.6	7.6	7.5	7.8	8.1
9	MAY 96	7.54	7.6	7.54	7.5	7.82	7.45	7.6	7.5	7.9	7.8	8.3
10	JUN. 96	7.09	7.7	7.7	7.8	8	7.7	7.6	8	7.9	7.8	8.6
11	JUL. 96	7.2	7.2	7.21	7.3	7.8	7.3	7.4	7.4	7.7	7.4	8.2
12	AUG. 96	7.3	7.3	7.7	7.4	7.7	7.3	7.4	7.8	7.8	7.3	8.25

Histogram - 16 A

MONTHLY VARIATIONS OF pH VALUE AT 11 DIFFERENT SAMPLING LOCATIONS

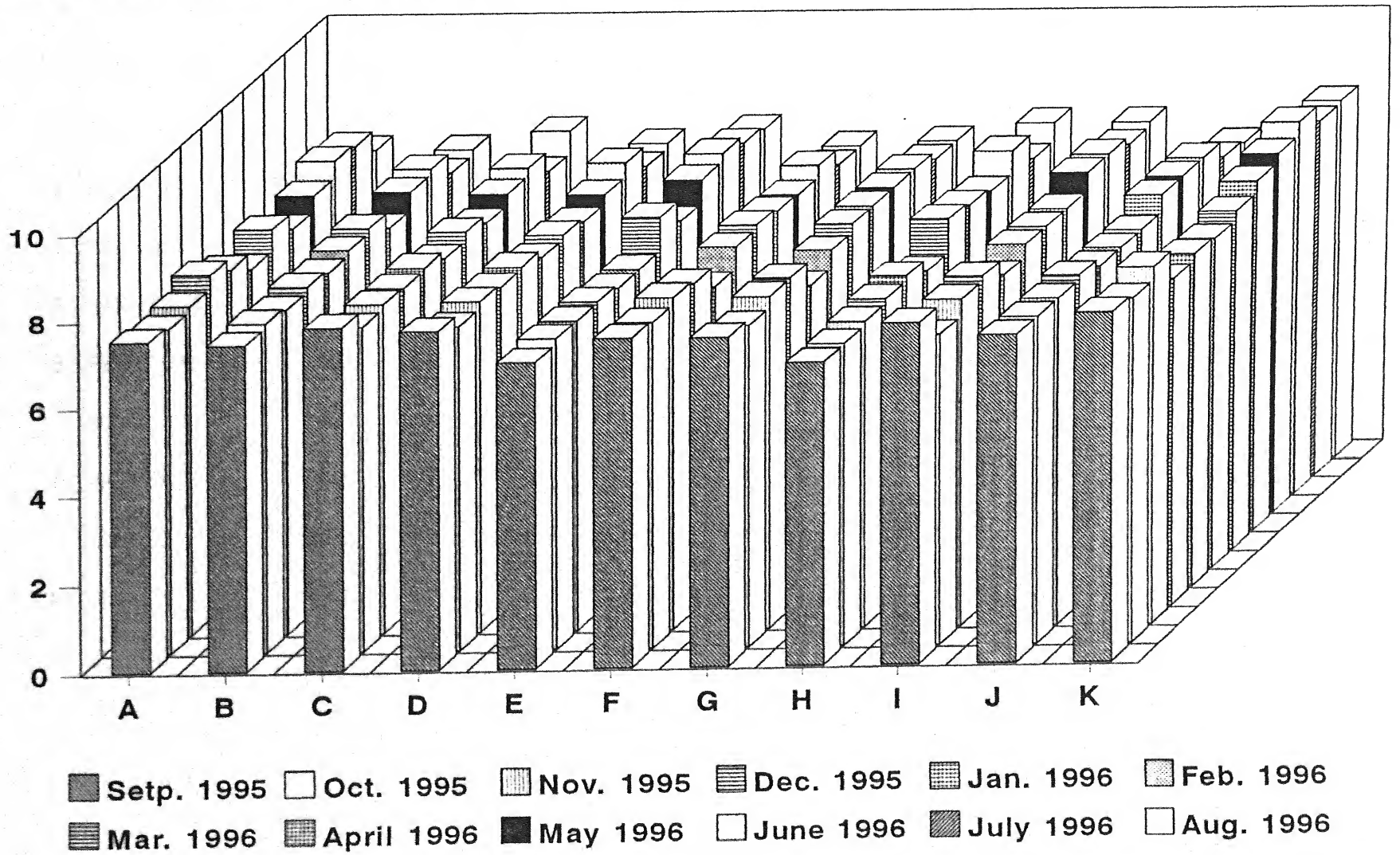


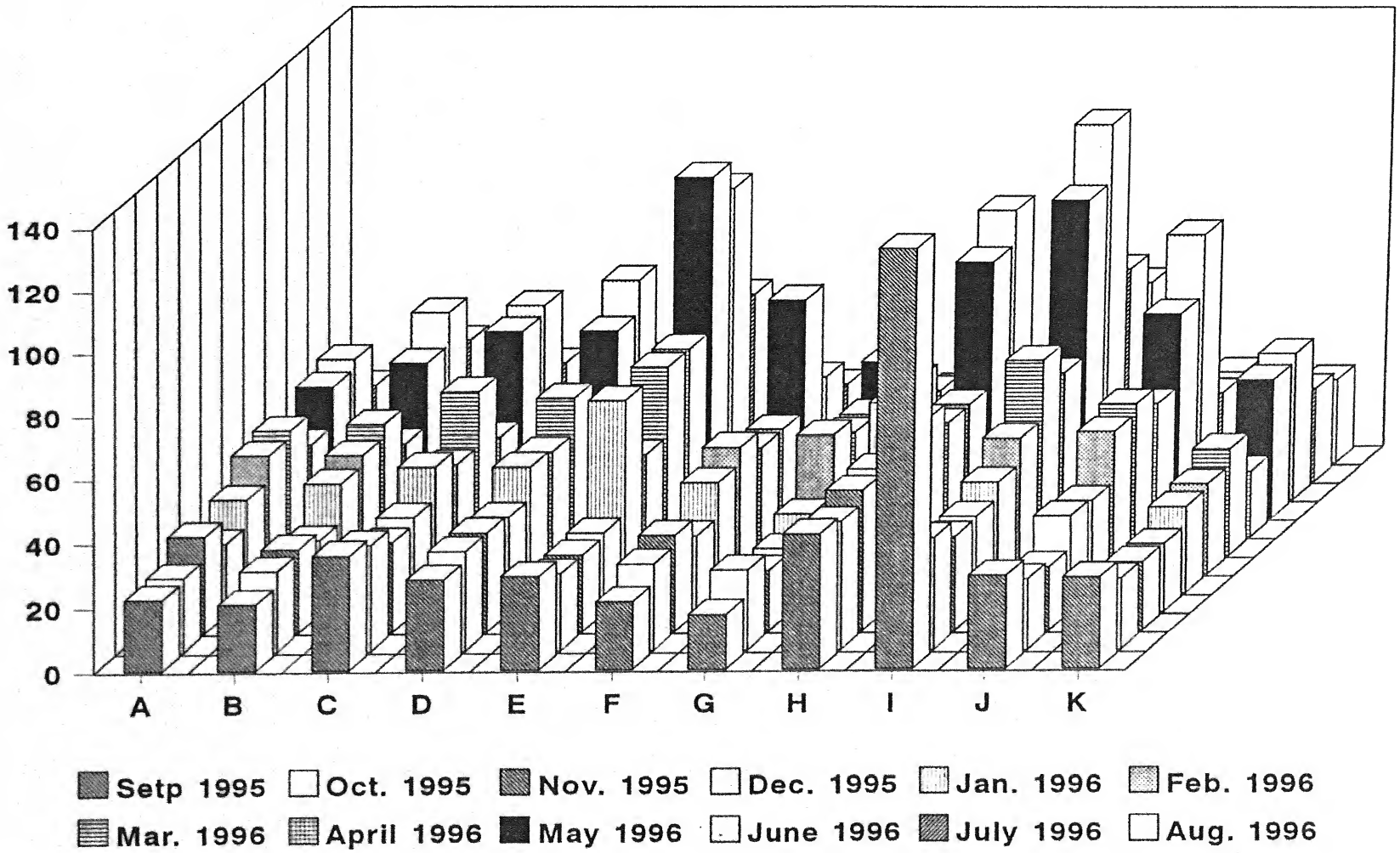
TABLE - 17

MONTHLY VARIATION'S IN CHLORIDE CONTENT'S (Mg/L) OF TAP WATER SUPPLY AT DIFFERENT SAMPLING LOCATION'S DURING THE STUDY PERIOD

S.N.	MONTH'S/YEAR	SAMPLING LOCATION'S										
		A	B	C	D	E	F	G	H	I	J	K
1	SEPT. 1995	22	20.5	35.5	28	29	21	16.9	42	133	29	28.4
2	OCT. 95	23	25	33	31	24	27	25	40	35	22	22.2
3	NOV. 95	30	26	28	31	24	30	19	44	29.5	20	21.5
4	DEC. 95	22	23	29.9	30	25	24	20	45	29.9	30	21.2
5	JAN. 1996	30	35	40	40	61	35	25	60.1	35	29	27
6	FEB. 96	38	38	35	39	38	40.2	44	49	43	45	28.5
7	MAR. 96	40	42	52.2	50.2	60	34.2	39	42	62	48	33.7
8	APR. 96	29.8	30	32	35.5	60	39.9	40	42	52.1	42.2	20.7
9	MAY 96	42.2	49.9	59.9	60.1	109.2	70	49.9	82.2	102.1	65.5	44.1
10	JUN. 96	45.2	60.2	62.5	70.5	99.9	39.2	38.5	92.9	120.2	85.1	46.7
11	JUL. 96	32.1	45.5	38.2	39.9	60.2	31	29	29.1	68.2	28.2	29.5
12	AUG. 96	25	29	30	28	50	25	24	29	58	29	26.5

Histogram - 17 A

MONTHLY VARIATIONS OF CHLORIDE CONTENTS (Mg/L) AT 11 DIFFERENT SAMPLING LOCATIONS



At sampling location 'F' minimum value of 21.0 mg/L was obtained in September 95 and maximum value of 70.0 mg/L was obtained in May 1996. Throughout rainy season it decreased and minimum value was count in September Sampling location 'G' showed a range between 16 9 to 49.9 mg/L Minimum value was in September and maximum value was in May 1996. During rainy season trend was the same as that of location 'F'. At sampling location 'H' chloride contents during the present investigation ranged between 29.0 mg/L to 92.9 mg/L. Where minimum value was in August. 96 and maximum value was in June 96. Sampling location 'I' showed high range between 29.5 mg/L to 133.0 mg/L. Where minimum value was observed in November 95 and maximum value was in September 95. This location was not exhibiting any definit pattern. At sampling location 'J' minimum value was observed as 20.0 mg/L in November 95 and maximum value 85.1 in June 96.

At sampling location's E & I chloride content's, when compared with other location's, were higher during summer & rainy season's. (Table -17)

8. Total Hardness (in mg/L) : The analytical data's of tap water of Jhansi showed wide range in total Hardness. It varied from a maximum value of 586.0 mg/L at sampling location 'I' in September 96 to a minimum of 104.0 mg/L at the sampling location 'C' in the month of February 96 (Table - 18 and Histogram18A). Higher values were generally obtained during summer months.

At the sampling location 'A' minimum value of total Hardness was 114.0 mg/L in February 96 and maximum value of 190.2 in May 96. Sampling location 'B' showed a narrow range between 120.0 mg/L to 180.0.mg/L Minimum value was in March 96 and maximum value in December 95. At sampling location 'C' minimum value was 104.0 mg/L in February 96 and maximum value of 170.2 mg/L in the month of June. At sampling location 'D' minimum value was recorded 112.0 mg/L in February 96 and maximum was value 164.2 mg/L in the month of June 96.

Sampling location 'E' showed higher values of total Hardness which ranged between 250.5 mg/L to 409.2 mg/L. Minimum value was found in July and the maximum value in June. At sampling location 'F' minimum value was observed i.e.

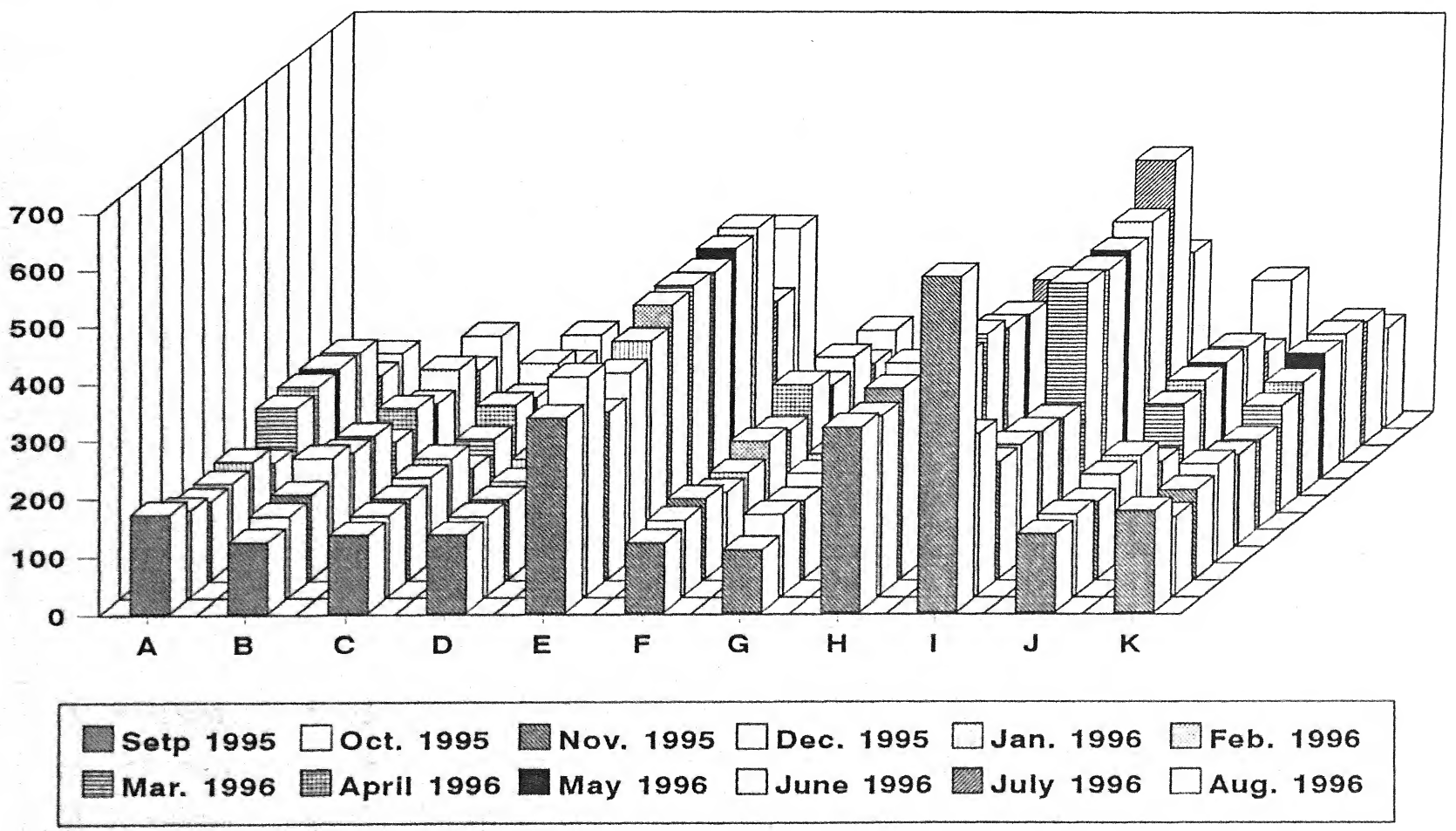
TABLE - 18

MONTHLY VARIATION'S IN TOTAL HARDNESS (Mg/L) OF TAP WATER SUPPLY AT DIFFERENT SAMPLING LOCATION'S DURING THE STUDY PERIOD

S.N.	MONTH'S/YEAR	SAMPLING LOCATION'S										
		A	B	C	D	E	F	G	H	I	J	K
1	SEPT. 1995	170.00	122.00	134.00	134.00	336.00	120.00	108.00	320.00	586.00	135.00	175.20
2	OCT. 95	148.00	138.00	138.00	137.00	380.00	130.00	140.00	310.00	280.00	140.00	136.00
3	NOV. 95	135.00	146.00	138.00	137.00	289.00	138.00	134.00	330.00	202.00	132.00	153.00
4	DEC. 95	136.00	180.00	145.00	139.00	328.00	120.00	152.00	345.00	202.00	150.00	168.80
5	JAN. 1996	145.00	160.00	150.00	149.00	355.00	125.00	158.00	320.00	196.00	155.00	155.60
6	FEB. 96	114.00	160.00	104.00	112.00	390.00	150.00	105.00	300.00	190.00	115.00	152.00
7	MAR. 96	180.00	120.00	125.00	138.00	395.00	140.00	148.00	309.00	400.00	185.00	182.00
8	APR. 96	188.80	150.00	155.00	140.90	389.90	190.00	185.00	290.90	395.00	198.80	195.00
9	MAY 96	190.20	129.90	140.00	135.00	402.00	160.50	180.50	285.00	399.40	200.20	215.60
10	JUN. 96	189.10	159.20	170.20	164.20	409.20	180.20	160.20	190.90	420.40	198.80	221.50
11	JUL. 96	120.00	129.20	140.20	155.10	250.50	140.20	150.20	289.20	500.00	160.60	214.20
12	AUG. 96	129.20	160.20	162.20	150.00	350.00	170.00	140.00	148.00	308.00	259.20	173.80

Histogram - 18 A

MONTHLY VARIATIONS OF TOTAL HARDNESS (Mg/L) AT 11 DIFFERENT SAMPLING LOCATIONS



120.0 mg/L in the month's of September and December and maximum value of 190.9 mg/L in the month of April 96.

Sampling location 'G' showed a range between 108.0 mg/l to 185.0 mg/L. Minimum value was recorded in September 95 and maximum value in April 96.

Sampling location 'H' showed a range between 148.0 mg/L to 345.0 mg/L. Minimum value of 148.0 mg/L was recorded in August 96 and maximum value of 345.0 was recorded in December 95. Sampling location 'I' showed high range between 190.0 to 586.0 mg/L. Where minimum value was found in February 96 and maximum value was found in the month of September 95. At this location like that of location 'E' higher values were obtained throughout the year. At sampling location 'J' minimum value was 115.0 mg/L in February 96 and maximum value was 259.2 mg/L in the month of August 96.

9. **Total Alkalinity** : Analytical data for bicarbonate alkalinity of water revealed positive results while tests for hydroxide gave negative results. Carbonate alkalinity could be detected occasionally that too only in a very few sampling location's.

Total Alkalinity varied from a minimum value of 96.0 mg/L at the sampling location 'G' (in the month of September 95) to a maximum value of 430.0 mg/L at the sampling location 'E' (in the month of June, Table - 19 and Histogram19A).

At the sampling location 'A' value of alkalinity varied from 98.0 mg/L to 200.0 mg/L. Minimum value in the month of March 96 and maximum value in the month of May 96. After March the alkalinity value increased throughout summer season followed by a decline in the rainy season and finally reached the minimum value in winter month of February 96. At the location 'B', minimum value was obtained in the month of September i.e. 105 mg/L and maximum value of 149.2 mg/L in the month of June. At the sampling location 'C' the value of total alkalinity showed a ranged between 102.0 to 180.0 mg/L. The minimum value was found during February 96 and maximum value was in the month of June 96.

At location 'D' minimum value 98.0 mg/L in the month of February 96 and maximum value was 168.2 mg/L in the month of June 96. At location 'E' the values of alkalinity were high during the period of investigations. Minimum value was 215.0 mg/L in the month of February 96 and maximum value was 430.3 mg/L

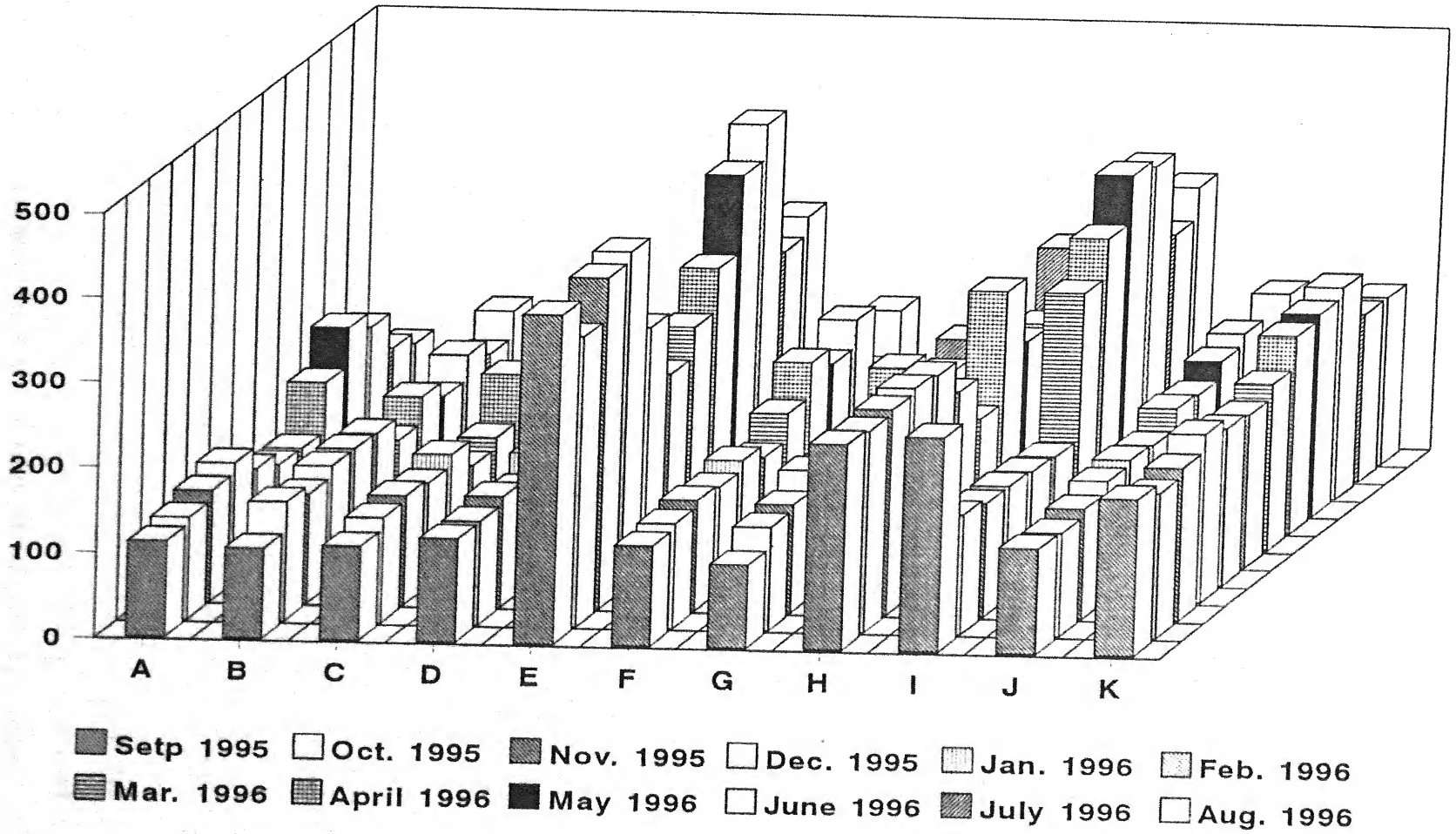
TABLE - 19

MONTHLY VARIATION'S IN TOTAL ALKALINITY (Mg/L) OF TAP WATER SUPPLY AT DIFFERENT SAMPLING LOCATION'S DURING THE STUDY PERIOD

S.N.	MONTH'S/YEAR	SAMPLING LOCATION'S										
		A	B	C	D	E	F	G	H	I	J	K
1	SEPT. 1995	112.00	105.00	109.00	120.00	386.00	116.00	96.00	240.00	250.00	122.00	181.80
2	OCT. 95	119.00	139.00	122.00	120.00	340.00	122.00	120.00	235.00	139.00	120.00	168.80
3	NOV. 95	130.00	128.00	128.00	129.00	390.00	129.00	126.00	240.00	132.00	128.00	178.00
4	DEC. 95	142.00	140.00	122.00	118.00	401.00	124.00	146.00	245.00	132.00	140.00	198.00
5	JAN. 1996	115.00	140.00	135.00	139.00	290.00	135.00	139.00	240.00	129.00	145.00	184.10
6	FEB. 96	99.00	138.00	102.00	98.00	215.00	119.00	115.00	200.00	126.00	142.00	180.20
7	MAR. 96	98.00	110.00	115.00	136.00	250.00	150.00	119.00	148.00	300.00	165.00	196.00
8	APR. 96	155.00	140.00	168.90	135.00	300.00	190.00	185.90	280.00	345.00	160.60	233.00
9	MAY 96	200.00	120.20	135.00	148.00	390.90	168.20	139.90	200.00	400.20	180.50	239.00
10	JUN. 96	180.10	149.20	180.10	168.20	430.30	200.20	140.10	200.20	390.20	192.80	251.00
11	JUL. 96	135.00	130.20	120.90	140.20	260.00	120.20	159.20	270.90	289.00	145.00	198.50
12	AUG. 96	120.10	161.20	156.60	145.00	280.80	171.10	133.70	170.70	325.30	200.00	198.20

Histogram - 19 A

MONTHLY VARIATIONS OF TOTAL ALKALINITY (Mg/L) AT 11 DIFFERENT SAMPLING LOCATIONS



in the month of June 96. At the sampling location 'F' minimum value was 116.0 mg/L during September 95 while maximum value of 200.2 mg/L was in June 1996. At the sampling location 'H' minimum value was 148.0 mg/L in the month of March and maximum value of 280.0 mg/L in the month of April 96.

At sampling location 'I' value of alkalinity showed a wide range from 126.0 mg/L to 400.2 mg/L. The minimum value was in February 96 and maximum value was in May 1996.

At location 'J' minimum value was 120.0 mg/L in October 95 and maximum value was 192.8 mg/L in the month of June 96.

10. **Carbonate Content's (in mg/L) :** The seasonal variation's in carbonate contents of tap water supply of Jhansi range between nil to 56.0 mg/L. Where minimum value 'nil' was obtained in all the sampling location's during most of the observation period. Maximum value of 56.0 mg/L was in October 95 at sampling location 'E' (Table - 20 and Histogram 20A).

At sampling location 'A' carbonate alkalinity was obtained only during the month's of February, April, July, August 96 and maximum value 24.0 mg/L was recorded in August 96. Sampling location 'B' showed carbonate contents only during the months of oct, December, February. & August with the maximum value of 20.0 mg/L in October During rest of the period Carbonate contents was 'nil'. Sampling location 'C' showed carbonate contents only during the months of December February, & March with the maximum value of 20.0 mg/L in the month of December 95. Location 'D' showed carbonate contents only during the month's of February & May with the maximum value of 16.0 mg/L in the month of February 96. Sampling location 'E' showed carbonate contents only during the month of October 95 with the value of 56.0 mg/L. Sampling location 'F' showed carbonate contents only during the months of March 96 with the value of 29.9 mg/L. At the sampling location 'G' carbonate contents was found only in the month of october 95 with the value of 14.0 mg/L.

At the sampling location 'H' carbonate contents was found only during the month of February 96 with the value of 16.0 mg/L. Sampling location 'I' showed carbonate contents only in the month of February 96 with the value of 12.0 mg/L.

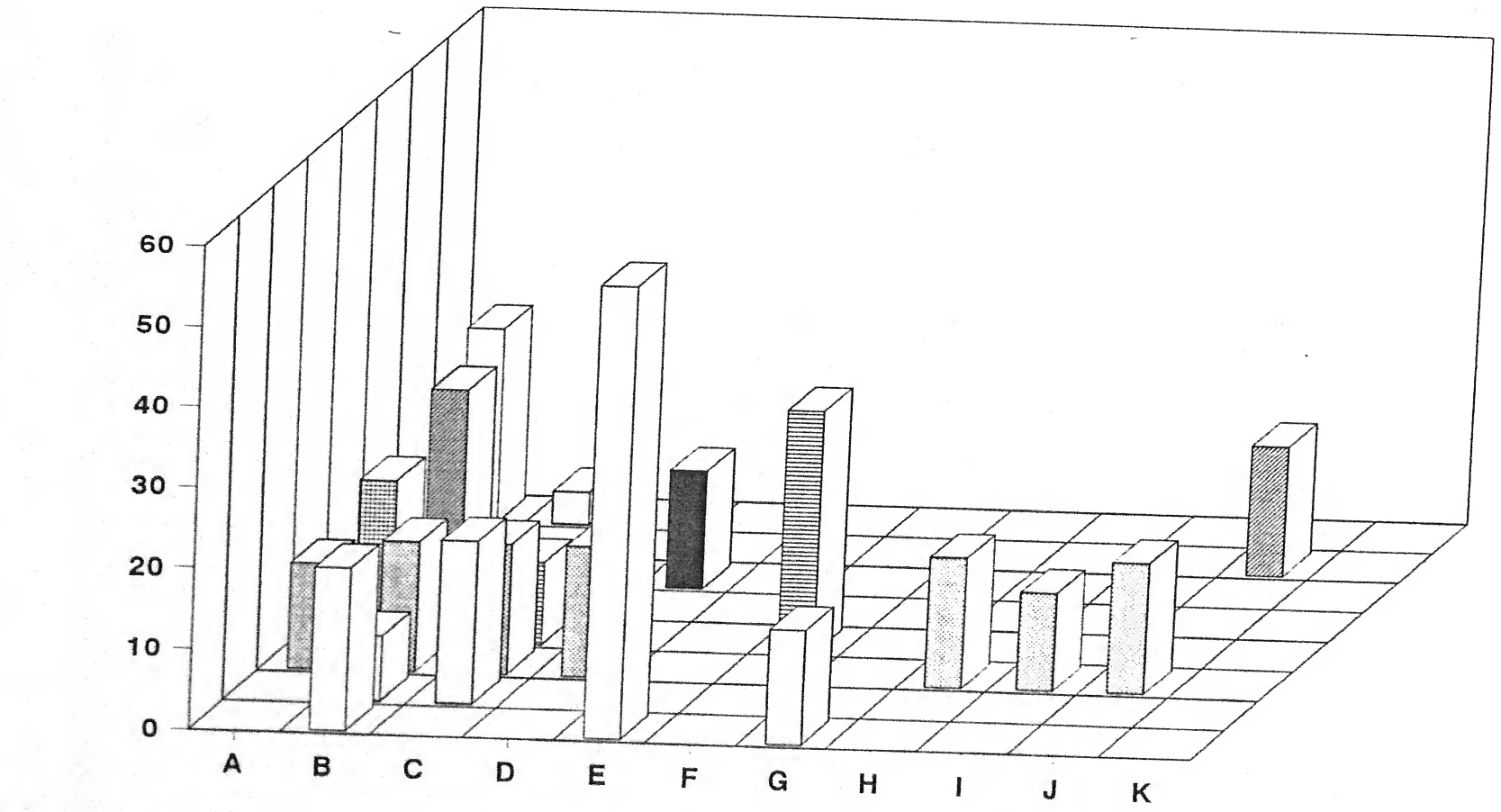
TABLE - 20

MONTHLY VARIATION'S IN CARBONATE CONTENTS (Mg/L) OF TAP WATER SUPPLY OF JHANSI AT DIFFERENT SAMPLING LOCATION'S DURING THE STUDY PERIOD

S.N.	MONTH'S/YEAR	SAMPLING LOCATION'S										
		A	B	C	D	E	F	G	H	I	J	K
1	SEPT. 1995	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
2	OCT. 95	Nil	20.00	Nil	Nil	56.00	Nil	14.00	Nil	Nil	Nil	Nil
3	NOV. 95	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
4	DEC. 95	Nil	8.00	20.00	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
5	JAN. 1996	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
6	FEB. 96	13.00	16.00	16.00	16.00	Nil	Nil	Nil	16.00	12.00	16.00	Nil
7	MAR. 96	Nil	Nil	10.10	Nil	Nil	29.90	Nil	Nil	Nil	Nil	Nil
8	APR. 96	16.00	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
9	MAY 96	Nil	Nil	Nil	14.50	Nil	Nil	Nil	Nil	Nil	Nil	Nil
10	JUN. 96	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
11	JUL. 96	20.00	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	16.00	Nil
12	AUG. 96	24.00	4.00	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil

Histogram - 20. A

MONTHLY VARIATIONS OF CARBONATE CONTENTS (Mg/L) AT 11 DIFFERENT SAMPLING LOCATIONS



At the sampling location 'J' carbonate contents was found only during the months of February 96 & July 96 with the same values of 16.0 mg/L.

11. Bicarbonate Conten's (in mg/L): During the present investigation the value's of bicarbonate showed a wide range between 82.0 to 430.3 mg/L. Where minimum value of 82.0 in February 96 at the location 'D' and maximum value was 430.3 mg/L in the month of June 96 at the sampling location 'E' (Table - 21 and Histogram 21A).

At the sampling location 'A' minimum value was 86.0 in February 96 and maximum value of 200.0 mg/L was observed in the month of May 96. Sampling location 'B' showed bicarbonate range between 105.0 to 157.9 mg/L. Where minimum value was found in September 95 and maximum value in August 96. At sampling location 'C' minimum value was recorded 86.0 in February 96 and maximum value of 180.1 mg/L in June 96. Sampling location 'D' showed a range between 82.0 to 168.2 mg/L where minimum value of 82.0 mg/L was recorded in Feb. 96 and maximum value of 168.2 mg/L in June 96. Sampling location 'E' showed high range of bicarbonate i.e.215.0 to 430.3 mg/L. Where minimum value was in February 96 and maximum value was in June 96. This sampling location showed very high value's of bicarbonate contents. At sampling location 'F' minimum value was 116.0 in the month of September 95 and maximum value was 200.2 mg/L in June 96. Sampling location 'G' showed a range between 96.0 to 185.9 mg/L where minimum value was 96.0 mg/L in September 95 and maximum value was 185.9 mg/L in April 96. At sampling location 'H' minimum value was 148.0 mg/L in the month of March 96 and maximum value was 280.0 mg/L in April 96. Sampling location 'I' minimum value was found 114.0 mg/L in February 96 and maximum value was 400.2 mg/L in May 96. In summer, after reaching to the peak value of 400.2 mg/L in the month of May 96, bicarbonate contents slowly dropped during the rainy & winter seasons reaching to the minimum value in February 96. At sampling location 'J' minimum value of 120.0 mg/L was found in the month of october 95 and maximum value of 200.0 mg/L in August 96 successively.

From above it is clear that generally bicarbonate contents were high during summers.

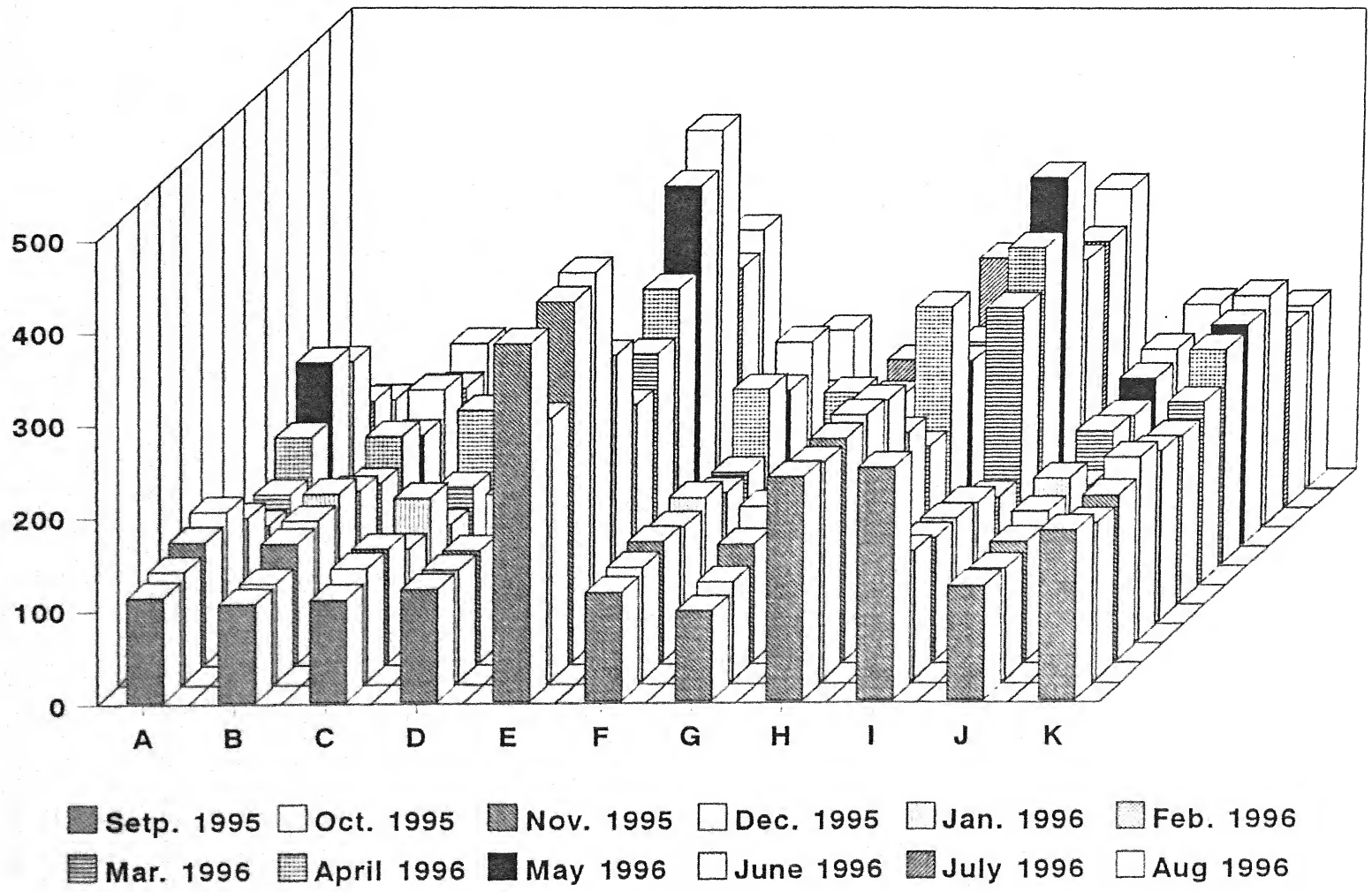
TABLE - 21

MONTHLY VARIATION'S IN BICARBONATE CONTENTS (Mg/L) OF TAP WATER SUPPLY OF JHANSI AT DIFFERENT SAMPLING LOCATION'S DURING THE STUDY PERIOD

S.N.	MONTH'S/YEAR	SAMPLING LOCATION'S										
		A	B	C	D	E	F	G	H	I	J	K
1	SEPT. 1995	112.00	105.00	109.00	120.00	386.00	116.00	96.00	240.00	250.00	122.00	181.80
2	OCT. 95	119.00	106.00	122.00	120.00	284.00	122.00	106.00	235.00	139.00	120.00	168.80
3	NOV. 95	130.00	128.00	122.00	120.00	390.00	129.00	126.00	240.00	132.00	128.00	178.00
4	DEC. 95	142.00	132.00	101.00	98.00	401.00	124.00	146.00	245.00	132.00	140.00	198.00
5	JAN. 1996	115.00	140.00	135.00	139.00	290.00	135.00	139.00	240.00	129.00	155.00	184.10
6	FEB. 96	86.00	122.00	86.00	82.00	215.00	119.00	115.00	184.00	114.00	126.00	180.20
7	MAR. 96	98.00	110.00	105.00	136.00	250.00	120.00	119.00	148.00	300.00	165.00	196.00
8	APR. 96	139.00	140.00	168.00	135.00	300.00	190.00	185.90	280.00	345.00	160.60	233.00
9	MAY 96	200.00	120.20	135.00	133.90	390.90	168.20	139.90	200.00	400.20	180.50	239.00
10	JUN. 96	180.10	149.20	180.10	168.20	430.30	200.20	140.10	200.20	390.20	192.30	251.00
11	JUL. 96	115.80	130.20	120.90	140.20	260.00	120.20	159.20	270.90	289.00	130.20	198.50
12	AUG. 96	96.50	157.90	156.60	145.00	280.80	171.10	133.70	170.70	325.30	200.00	198.20

Histogram - 21 A

MONTHLY VARIATIONS OF BICARBONATE CONTENTS (Mg/L) AT 11 DIFFERENT SAMPLING LOCATIONS



12. Free Carbondioxide (in mg/L) : During the period of investigation of tap water, seasonal variation in free Co_2 ranged between nil to 31.68 mg/L. Minimum value was observed in all the sampling location in one or the other months during the observation period. While maximum value was 31.68 mg/L in September and June from sampling location 'I' (Table - 22 and Histogram 22A).

During the whole year free carbondioxide of tap water showed high variation at the sampling location 'I'.

At the sampling location 'A' minimum free Co_2 value was recorded 'nil' in the month's of April, July and August and maximum value of 7.92 mg/L was recorded in September 95. At the sampling location 'B' minimum free Co_2 value was observed nil in the months of October December, February., and August and maximum value of 7.04 was recorded in May. At the sampling location 'C' minimum value 'nil' in the month's of December, February, & March and maximum value of 7.92 was in September. At the sampling location 'D' minimum value 'nil' was recorded in the month's of December, February and May and maximum value of 10.56 mg/L in the month of June. Sampling location 'E' free Co_2 range from nil to 15.84 mg/L. At this station minimum value nil, in the month of October and maximum value was 15.84 mg/L in the month of May. At the sampling location F, G & H it ranged between nil to 13.2 mg/L. Where minimum value recorded 'nil' during the March, October and February and maximum value of 13.2 mg/L was recorded in the month of September from sampling location 'H'.

Sampling location 'I' showed wide range of free Co_2 from nil to 31.68 mg/L where minimum value recorded 'nil' in the month of February 96 and maximum value of 31.68 mg/L in the months of September & June. At the sampling location 'J' minimum value 'nil' in the months of February & July and maximum value of 7.2 mg/L in the month of January 96.

13. Total Carbondioxide (in Mg/L) : The analytical data's of total carbon-di-oxide of tap water showed a range between 91.0 mg/L to 8415.0 mg/L. In which minimum value of 91.0 was observed in February 96 at sampling location 'C' and maximum value 8415.0 mg/L was observed in September 95 at the sampling location 'E'. (Table - 23 and Histogram 23A). Exhibiting general pattern of low value's in winter and high values in summer & rainy season.

TABLE - 22

MONTHLY VARIATION'S IN FREE CARBONDIOXIDE (Mg/L) OF TAP WATER SUPPLY AT DIFFERENT SAMPLING LOCATION'S DURING THE STUDY PERIOD

S.N.	MONTH'S/YEAR	SAMPLING LOCATION'S										
		A	B	C	D	E	F	G	H	I	J	K
1	SEPT. 1995	7.92	3.52	7.92	3.52	10.56	1.76	3.52	13.20	31.68	5.64	5.30
2	OCT. 95	5.28	Nil	5.28	7.04	Nil	5.28	Nil	12.50	1.76	2.80	4.70
3	NOV. 95	4.40	2.60	5.28	7.04	10.80	3.50	2.90	13.20	17.60	2.60	9.40
4	DEC. 95	5.28	Nil	Nil	Nil	9.14	5.40	7.04	10.00	17.60	5.20	4.65
5	JAN. 1996	5.26	6.20	7.50	7.20	13.50	2.50	5.28	12.20	5.20	7.20	8.50
6	FEB. 96	Nil	Nil	Nil	Nil	12.50	2.50	2.90	Nil	Nil	Nil	7.89
7	MAR. 96	3.00	2.00	Nil	4.00	8.00	Nil	1.00	3.00	9.00	4.00	2.70
8	APR. 96	Nil	4.00	6.00	2.00	14.00	6.00	7.00	12.00	13.00	2.00	8.40
9	MAY 96	8.80	7.04	5.28	Nil	15.84	3.52	7.04	1.76	17.60	5.28	10.10
10	JUN. 96	7.04	3.52	7.04	10.56	14.08	10.50	7.20	13.20	31.60	12.32	9.70
11	JUL. 96	Nil	5.28	5.28	7.04	9.00	1.76	2.80	12.50	12.50	Nil	5.80
12	AUG. 96	Nil	Nil	1.75	7.04	7.04	5.28	2.80	1.76	5.28	3.04	4.20

Histogram - 22 A.

MONTHLY VARIATIONS OF FREE CARBONDIOXIDE (Mg/L) AT 11 DIFFERENT SAMPLING LOCATIONS

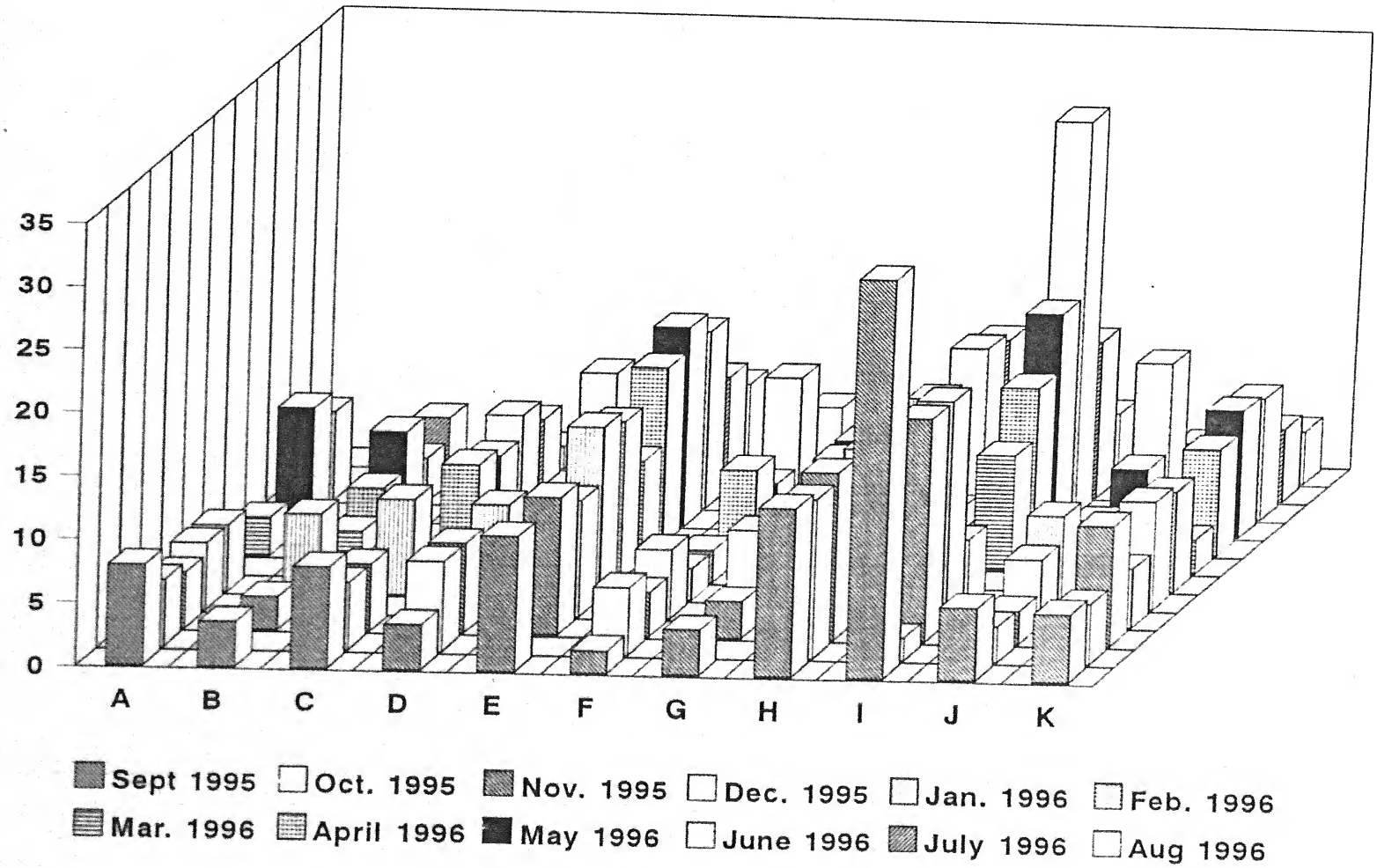


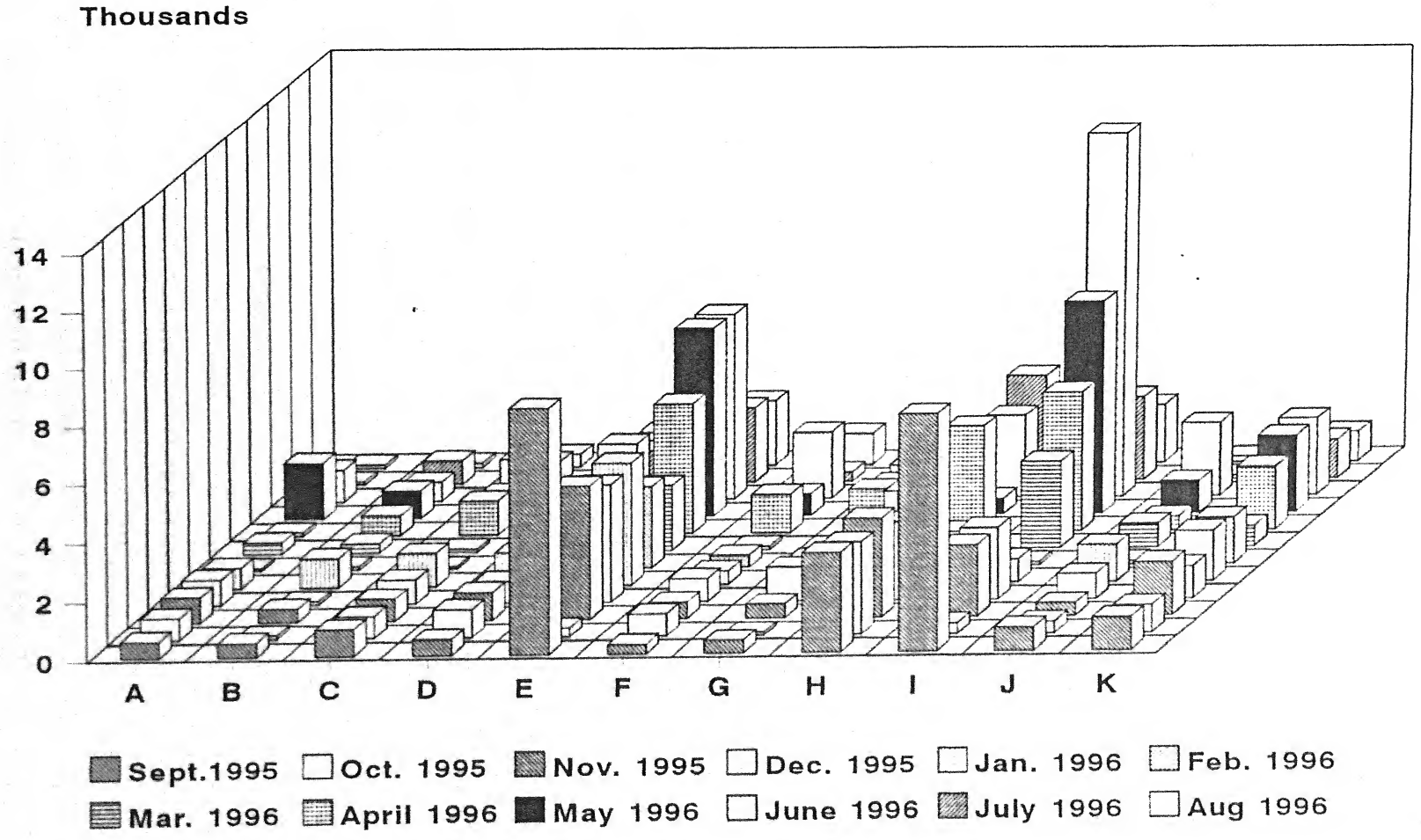
TABLE - 23

MONTHLY VARIATION'S IN TOTAL CARBONDIOXIDE (Mg/Litre) OF TAP WATER SUPPLY AT DIFFERENT SAMPLING LOCATION'S DURING THE STUDY PERIOD

S.N.	MONTH'S/YEAR	SAMPLING LOCATION'S										
		A	B	C	D	E	F	G	H	I	J	K
1	SEPT. 1995	531.50	462.00	901.90	528.00	8415.00	306.20	422.00	3379.00	8140.00	795.00	1123.50
2	OCT. 95	751.00	130.90	751.00	950.00	305.00	751.00	107.20	3144.30	366.00	401.00	941.50
3	NOV. 95	866.40	445.40	751.00	950.00	4555.20	565.00	476.00	3370.00	2439.00	445.00	1829.80
4	DEC. 95	874.70	120.10	816.00	733.40	4008.00	778.00	1156.30	2665.60	2439.30	851.20	1094.90
5	JAN. 1996	706.10	991.00	1131.30	1123.00	4170.00	456.30	856.00	3139.20	784.30	1252.40	1725.90
6	FEB. 96	91.60	123.30	91.00	670.30	2769.20	402.20	434.70	177.90	112.30	126.80	1578.60
7	MAR. 96	380.00	316.80	97.45	633.60	2220.20	120.00	223.70	574.20	2964.00	805.20	701.60
8	APR. 96	138.70	683.20	1162.00	388.80	4464.00	1307.20	1464.80	3606.40	4788.60	460.80	2162.20
9	MAY 96	1936.00	950.40	831.60	132.30	6520.80	740.08	1108.00	528.00	7395.60	1108.30	2637.30
10	JUN. 96	1108.80	656.40	1425.60	1924.20	6432.80	2276.00	1131.20	2816.00	########	2524.40	2655.50
11	JUL. 96	121.20	800.80	739.20	1108.80	2568.80	316.80	585.80	3624.60	2866.80	130.20	1325.90
12	AUG. 96	108.90	142.90	411.80	1148.40	2223.90	1053.90	492.00	450.60	2003.80	184.00	1006.80

Histogram - 23 . A.

MONTHLY VARIATIONS OF TOTAL CARBONDIOXIDE (Mg/L) AT 11 DIFFERENT SAMPLING LOCATIONS



At sampling location 'A' minimum value of 91.6 mg/L was recorded during the Febrary. 96 and maximum value of 1936.0 mg/L in the month of May 96. Sampling location 'B' showed a range between 120.0 to 991.0 mg/L where minimum value of 120.0 mg/L in December. 95 and maximum value of 991.0 mg/L in January 96. Sampling location 'C' showed a range between 91.0 to 1425.6 mg/L. Minimum value of 91.0 mg.L was observed in month of Febrary 96 and maximum value of 1425.6 mg/L in June 96. At the sampling location 'D' minimum value of 132.3 in the month of may and maximum value of 1924.2 mg/L was observed inJune 96. Sampling location 'E' showed wide range. Where minimum value of 305.0 mg/L in october 95 and maximum value of 8415.0 mg/L in Septemer. 95. At the sampling location 'F' minimum value of 120.0 mg/L in March and maximum value of 2276.0 mg/L was recorded in the month of June 96. Sampling location 'G' showed a range between 107.0 to 1464.8 mg/L. Minimum value of 107.0 mg/L in October 95 and maximum value was observed 1464.8 mg/L in April 96. At the sampling location 'H' minimum value of 177.9 mg/L was observed in february 96 and maximum value of 3624.6mg/L in July. Sampling location 'I' showed wide range between 112.3 to 8140.0 mg/L. In which minimum value of 112.3 mg/L was in Feburary. 96 and maximum value of 8140.0 mg/L was in September 95. At the sampling location 'J' minimum value of 126.8 mg/L was observed in February. 96 and maximum value of 2524.4 mg/L was in June 96.

14. **Dissolved oxygen (in mg/l)** : Analytical data's for dissolved oxygen of water showed minimum value of dissolved oxygen was 4.0 mg/L at the sampling location 'E' in the month of June 96 and maximum value of D.O. at the sampling location 'D' i.e. 9.2 mg/L in the month of February. 96. (Table - 24 and Histogram 24A).

There was a general tendency in dissolved oxygen to increase after summer and decrease after winter. Low value of D.O. were generally obtained during June 96. The amplitude of fluctuation's in dissolved oxygen is less.

At the sampling location 'A' minimum value was 6.0 mg/L in the month of June 96 and maximum value was 9.0 mg/L in the month of February 96. At the sampling location 'B' minimum & maximum value's were 6.2 and 9.1 mg/L during the month of June 96 and February 96 respectively, after June values were

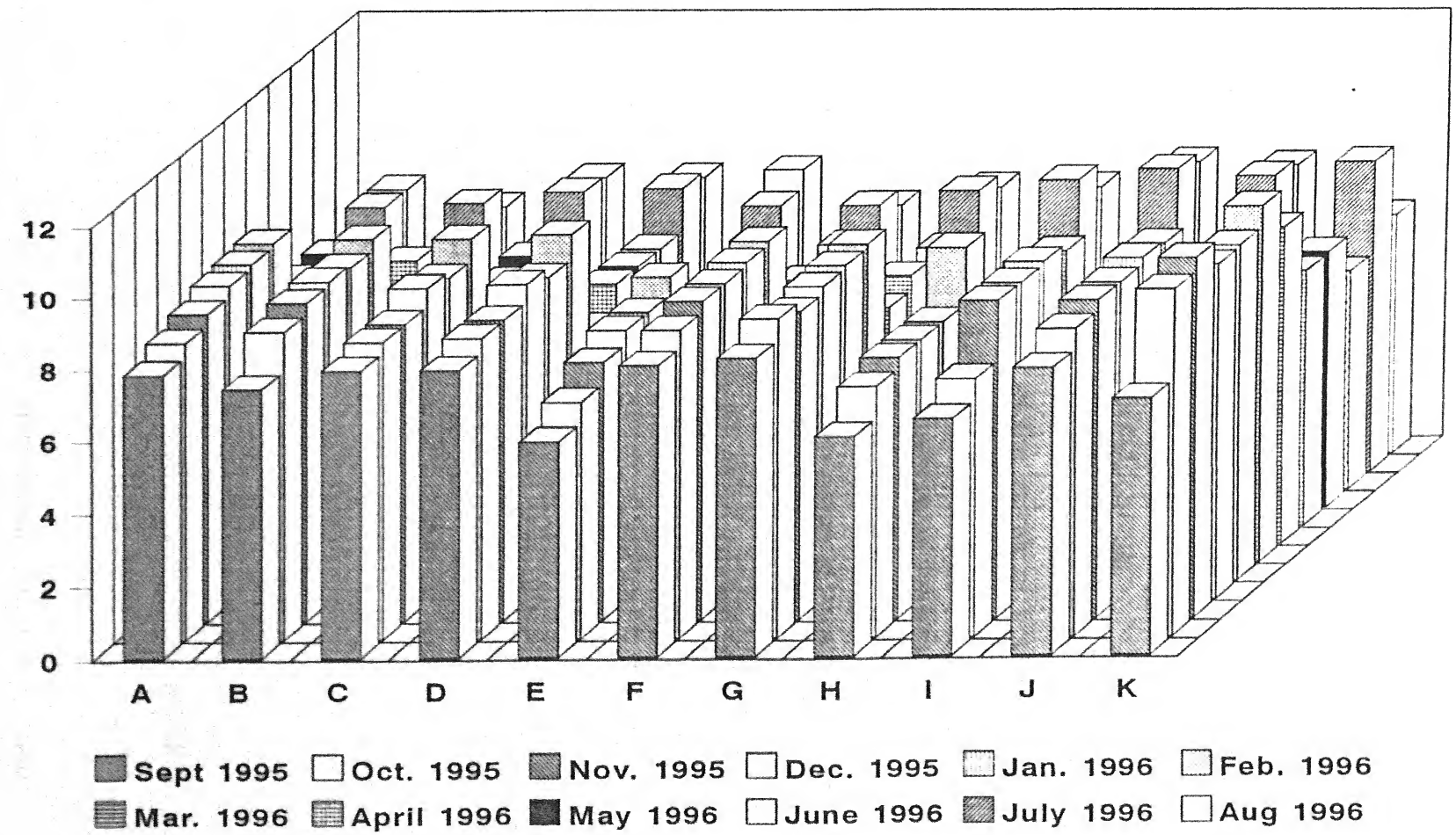
TABLE - 24

MONTHLY VARIATION'S IN DISSOLVED OXYGEN (Mg/L) OF TAP WATER SUPPLY OF JHANSI AT DIFFERENT SAMPLING LOCATION'S DURING THE STUDY PERIOD

S.N.	MONTH'S/YEAR	SAMPLING LOCATION'S										
		A	B	C	D	E	F	G	H	I	J	K
1	SEPT. 1995	7.80	7.40	7.90	7.90	5.90	8.00	8.20	6.00	6.50	7.90	7.05
2	OCT. 95	8.20	8.50	8.20	8.30	6.50	8.50	8.80	6.90	7.10	8.50	9.60
3	NOV. 95	8.50	8.80	8.20	8.30	7.10	8.80	8.50	7.20	8.80	7.40	10.10
4	DEC. 95	8.80	8.90	8.70	8.80	7.50	8.80	8.70	7.20	8.80	8.80	9.30
5	JAN. 1996	8.90	8.80	8.50	8.50	7.50	8.90	8.80	7.20	8.90	9.00	9.35
6	FEB. 96	9.00	9.10	9.10	9.20	8.00	9.00	8.90	8.80	8.70	8.90	9.95
7	MAR. 96	7.50	6.80	6.90	6.10	4.90	6.20	6.60	6.50	6.60	6.90	8.85
8	APR. 96	7.00	7.50	6.90	6.80	5.99	6.90	7.00	6.10	6.20	7.00	7.10
9	MAY 96	7.20	7.00	7.10	6.80	5.20	6.20	6.10	6.00	5.90	6.00	7.15
10	JUN. 96	6.00	6.20	6.90	6.80	4.00	6.90	6.80	5.90	5.50	6.00	6.10
11	JUL. 96	7.50	7.60	7.90	8.00	7.50	7.50	7.90	8.20	8.50	8.30	8.10
12	AUG. 96	7.50	7.00	7.80	7.80	8.00	7.00	7.50	7.50	8.20	8.10	6.70

Histogram - 24. A.

MONTHLY VARIATIONS OF DISSOLVED OXYGEN (Mg/L) AT 11 DIFFERENT SAMPLING LOCATIONS



increased during rainy season and maximum value was obtained in winter month of February 96. Sampling location 'C' showed a range between 6.9 to 9.1 mg/L. Where minimum value was found in the month of June 96 and maximum value was in the month of February 96. At sampling location 'D' minimum value was 6.1 mg/L in the month of march 96 and maximum value was 9.2 mg/L in the month of February 96. After March values slowly increased throughout the rainly season and reached to the maximum value in winter months. Sampling location 'E' showed a range of dissolved oxygen between 4.0 to 8.0 mg/L minimum value was found in the month of June 96 and maximum value in February 96.

At sampling location 'F' minimum value was 6.2 mg/L in the month of March & may 96 and maximum value was 9.0 mg/L in the month of February 96. Location 'G' showed a range between 6.1 to 8.9 mg/L. Where minimum value 6.1 mg/L was observed in the month of may 96 and maximum value 8.9 was observed in February 96. Sampling location 'H' showed minimum value of 5.9 mg/L in the month of June 96 and maximum value of 8.8 mg/L in the month of February 96. At the sampling location 'I' minimum value of 5.5 mg/L in the month of June 96 and maximum value of 8.9 was in the month of January 96. At the location 'J' minimum value of 6.0 mg/L in the month of May & June 96 and maximum value was 9.0 mg/L in the month of January 96.

From above observation, it is clear that there is a general tendency in dissolved oxygen to increase after summer and decrease after winter. All the 11 sampling location's exhibited almost the same upward and downward trend during rainy, winter and summer season with slight fluctuation's. Table 24 indicates that during summer, value of dissolved oxygen were low where as in winter season values were high.

15. <u>Biochemicaly Oxygen Demand (in mg/l)</u> : The analytical data's of biochemical oxygen demand was recorded only in the 6 months from March 96 to August 1996, because water generally had organic matter during these months' and during rest of the months it was generally clear (Table 25 and Histogram 25A).

At the sampling location 'A' B.O.D. of water sample showed a range between 0.9 to 1.29 mg/L. Where minimum value of 0.9 mg/l was recorded in

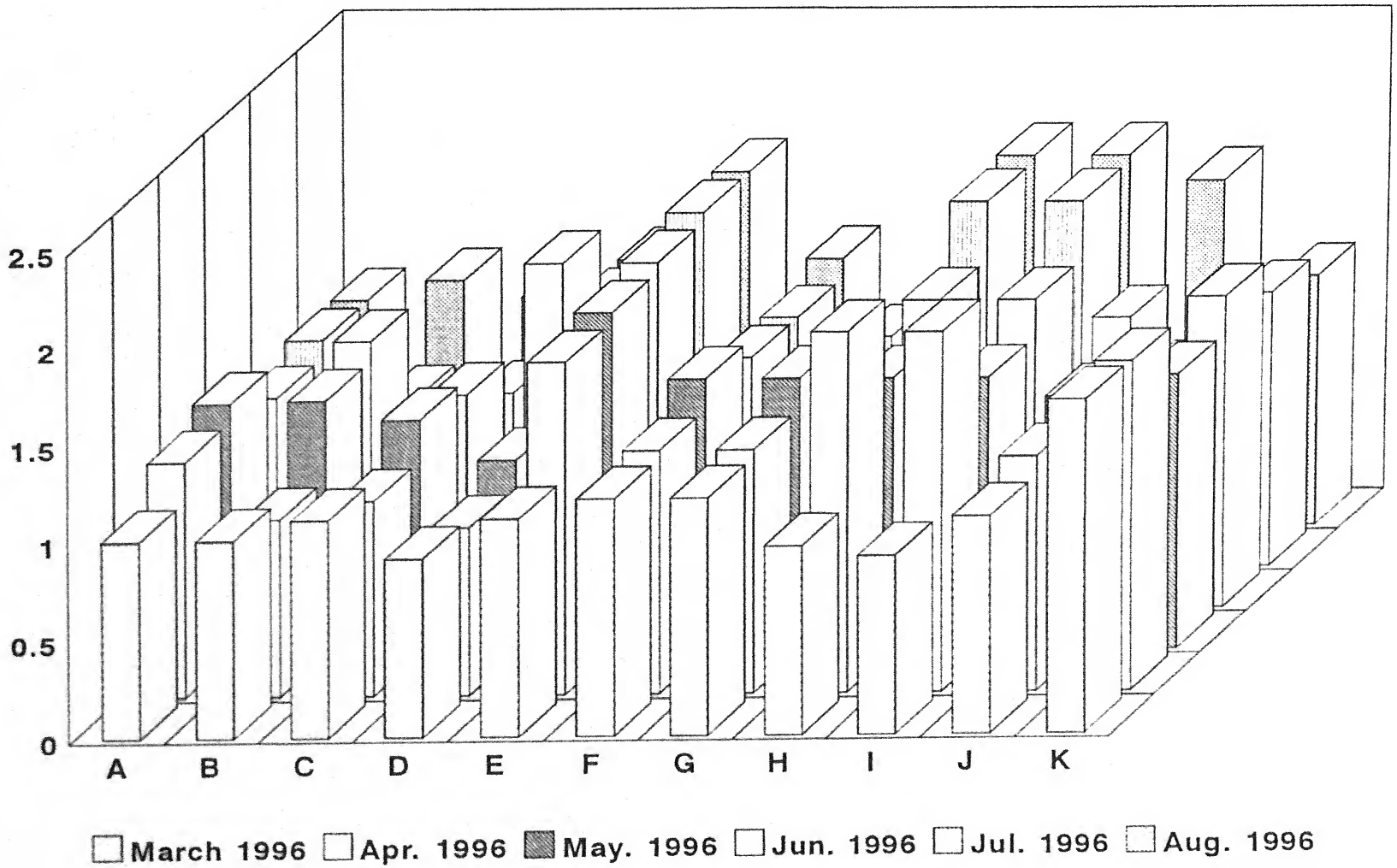
TABLE - 25

MONTHLY VARIATION'S IN BIOLOGICALY OXYGEN DEMAND (BOD Mg/L) OF TAP WATER AT DIFFERENT SAMPLING LOCATION'S DURING THE STUDY PERIOD

S.N.	MONTH'S/YEAR	SAMPLING LOCATION'S										
		A	B	C	D	E	F	G	H	I	J	K
1	MAR. 1996	0.90	1.00	1.10	0.90	1.10	1.01	1.20	0.95	0.90	1.10	1.70
2	APR. 1996	1.20	0.90	0.99	0.85	1.70	1.20	1.24	1.20	1.85	1.20	1.69
3	MAY 1996	1.29	1.30	1.20	0.99	1.75	1.00	1.40	0.80	1.40	1.30	1.41
4	JUN. 1996	1.11	1.40	1.12	1.80	1.80	1.30	1.30	1.80	1.60	1.50	1.61
5	JULY 1996	1.20	0.90	0.92	1.40	1.80	1.30	1.20	1.60	1.90	1.00	1.42
6	AUG. 1996	1.20	1.30	1.21	1.40	1.85	1.40	1.01	1.08	1.93	1.80	1.30

Histogram - 25 A

MONTHLY VARIATIONS OF BIOLOGICAL OXYGEN DEMAND (Mg/L) AT 11 SAMPLING LOCATIONS



March 96 and maximum value of 1.29 mg/L in May 96. Sampling location 'B' showed a range between 0.9 to 1.4 mg/l. Minimum value in the months of April & July and maximum value in June 96. Sampling location 'C' showed a range between 0.92 to 1.21 mg/L. Where minimum value was in July 96 and maximum value in August 96. Location 'D' showed a range between 0.85 to 1.8 mg/l, in which minimum value was in April 96 and maximum value in June 96. Location 'E' showed a range betwen 1.1 to 1.85 mg/l, Where minimum value was in March 96 and maximum value in August 96. At the sampling location 'F', B.O.D. of water samples showed a range between 1.0 to 1.4 mg/l. In which minimum value in the month of March & May 96 and maximum value in August 96. Sampling location 'G' showed a range between 1.01 to 1.4 mg/l. Where minimum value was in August 96 and maximum value in May 96. Sampling location 'H' showed a range between 0.95 to 1.8 mg/l. Where minimum value was in March 96 and maximum value in the month of June 96. At sampling location 'I', B.O.D. showed a range between 0.90 to 1.93 mg/l. Minimum value was in March 96 and maximum value in July and August 96. Sampling location 'J', showed a range between 1.0 to 1.80 mg/l. Minimum value in the month's of July & August 96 and maximum value in the month of June 96.

From above investigation, it is clear that generally there were very small changes in B.O.D. value's and at sampling locations E & I showed comparatively higher value's in all the 6 months.

Statistical analysis of physicochemical parameters has bee done and standard deviation , standard error and mean variability has been calculated seasonwise for all sampling locations. Datas obtained has been given from table 32 to 41.

SECTION - 5

MICROBIOLOGICAL STUDY

SECTION - 5

Chapter A - Phytoplanktonic Study

Microbial studies of water has a great significance specilly in developing countries like India. In such countries water routes, disposals of industrial wastes, sewage and agricultural practices all lead to water pollution. Seasonal variation in planktonic population, and accumulation organic & inorganic material brought by surface runoff lead to turbidity of water. Sometimes suddenly microscopic algal population flareoff and leads to what is called the "water bloom". This is either due to the multiplication of a single pecies or due to combination of species & may be confined either to a certaan part of the year or may persist through out the year. Generally during such multiplication some member's of Chlorophyceae, Cyanophyceae, Bacillariophyceae or Euglenophyceae are involved. These forms have rapid power of multiplication and sticky walls by which they adhere to each other and form dense mats or scum on the water surface. Their development is favoured because of their capacity to grow in long range of temperature and climatic conditions. Cyanophyceae forms are capable to fix atmospheric Nitrogen. Along with chlorophyll pigment they have phycocyanin which enable them to live in varying illuminations and habitals. Blue green algae specially dominate the algal flora of tropiical inland water. (Fritsch 1907; Geitler & Ruttner 1936).

These algal forms are often responsible for bad tastes & odour's of water and make water unfit for drinking and other domestic purposes from the point of view of health & even recreation. The pipeline water supply has the same source of water. In view of this algal population was studied in the part of the section. Since we were mainly concerned with the quality of water supplied we have not paid much attention towards the taxonomic analysis and restricted our studies to the quantitative an qualitative analysis only.

During our analysis we collected water at fort night intervals from all the 12 sampling locations. Since the abundance of algal forms were noted in E, I &

K sampling locations. Hence these locations were selected for detailed analysis.

Alltogether 20 aalgal species were recorded at the above 3 sampling locations. Out of these 6 belongs to Cyanophyceae, 7 to Chlorophyceae, 1 to Euglenophyceae & 8 to Bacillariophyceae. Oscillatoria and Spirogyra were absent at locations E & I. On the basis of occurrence algal species were classified into the following 6 categories.

1.	0	=	Rare
2.	+	=	Present
3.	++	=	Frequent
4.	+++	=	Abundant
5.	++++	=	Most abundant
6.	-	=	Absent.

In the preent study, 9 species viz. Microcystis aeruginosa, Anabaena constricta, Merismopedia punctala., Chlamydomonas sp., Chlorella vulgaris, Scenedesmus Acuminatus., Cyclotella operculata., Melosira varians, Navicula radiosa., Pinnularia viridis., and Synedra affinis were found most abundant.

Monthy variations in the total population of each group of algal have been expressed in fig-4,5,6 & Table 26 & 27, 28, 29 water comming through Matatila reservoir through pipeline to the filter plant at Babina had 185 x 10^3/L as maximum population of Chlorophyceae and 150x10^3/L, 72.5x10^3/L and 20x10^3/L as maximum population of Cyanophyceae, Bacillariophyceae, & Euglenophyceae respectively. At sampling location I, i.e. city area the maximum population of Chlorophyceae, Cyanophyceae, Bacillariophyceae & Euglenophyceae were 50x10^3/L, 36x10^3/L, 24x10^3/L & 13x10^3/L respectively. While at sampling location E. i.e. Bada bazar area, the maximum population of the four groups of algal were 31x10^3/L, 17.5x10^3/L 12x10^3/L and 7.5 x 10^3/L respectively.

Seasonal population of chlorophyceal were found to be maximum in winter followed by summer at all the three sampling locations. Maximum growth

TABLE-26

MONTHLY VARIATION'S IN DIFFERENT GROUPS OF ALGAL POPULATION (CELLS X 10^3/L) DURING THE STUDY PERIOD

S. NO.	MONTH'S/ YEAR	SAMPLING LOCATION'S											
		BADA BAZAR (E)				CITY AREA (I)				MATATILA RESERVOIR (K)			
		Eugleno-Phyceae	Bacillario-Phyceae	Cyano-Phyceae	Chloro-Phyceae	Eugleno-Phyceae	Bacillario-Phyceae	Cyano-Phyceae	Chloro-Phyceae	Eugleno-Phyceae	Bacillario-Phyceae	Cyano-Phyceae	Chloro-Phyceae
1.	September 1995	2.0	5.0	6.0	15.0	3.5	11.0	13.0	27.5	7.5	27.5	62.5	75.0
2.	October 95	5.0	6.0	7.0	20.0	7.5	13.0	12.5	38.0	12.5	30.0	87.5	100.0
3.	Novembar 95	3.0	8.0	12.5	25.0	5.0	14.0	22.0	42.0	7.5	40.0	125.0	140.0
4.	December 95	7.0	11.0	15.0	31.0	12.0	20.5	25.0	50.0	15.0	72.5	130.0	185.0
5.	January 1996	4.0	10.0	17.0	24.0	7.0	18.0	30.0	40.0	10.0	50.0	150.0	175.0
6.	February 96	7.5	7.0	6.0	26.0	13.0	13.5	20.0	10.0	20.0	40.0	122.5	145.0
7.	March 96	3.0	11.0	8.0	22.0	6.0	21.0	22.0	43.0	8.0	55.0	100.0	155.0
8.	April 96	5.0	10.0	12.0	25.0	8.0	20.0	25.0	46.5	9.5	65.0	87.5	150.0
9.	May 96	6.0	12.0	15.0	23.0	9.0	24.0	29.0	47.0	11.0	35.0	100.0	162.5
10.	June 96	7.0	9.0	17.5	27.0	10.0	19.0	36.0	50.0	10.0	32.5	137.5	147.5
11.	July 96	3.0	4.0	10.0	14.0	5.0	7.5	18.5	25.0	5.0	22.5	100.0	107.5
12.	August 96	3.5	5.5	6.5	12.5	6.5	10.0	11.0	22.0	8.0	27.5	62.5	92.5

TABLE - 27

MONTHLY VARIATION IN ALGAL POPULATION AT SAMPLING LOCATION 'E' (BADA BAZAR)

SN	FAMILY / SPECIES	MONTHS											
		S	O	N	D	J	F	M	A	M	J	J	A
	Cyanophyceae												
1	Microcystis aeruginosa	-	o	++	+++	++	+	++	+++	+++	+++	+	+
2	Anabaena constricta	-	o	++	++	++	+	+	++	+++	+++	++	+
3	Arthospira sp.	+	+	-	-	-	+	-	-	-	-	-	+
4	Merismopedia punctata	+	+	++	++	+++	+	+	+++	+++	+++	+	+
5	Oscillatoria	o	-	-	-	-	-	-	-	-	-	-	-
6	Phormedium	o	+	++	o	++	o	+	+	+	+	+	+
	Chlorophyceae												
1	Chlamydomonas sp.	+	+	++	+	++	++	-	+	++	-	++	o
2	Chlorella vulgaris	+	++	++	+	-	+	+	+	+	-	+	+
3	Cosmarium	o	+	++	o	++	o	+	-	+	++	-	++
4	Scenedesmus acuminatus	o	o	o	+	+	++	-	-	-	-	+	++
5	S. quadricauda	o	+	-	-	-	+	+	+	++	+++	-	+
6	Spirogyra	-	-	-	-	-	-	-	-	-	-	-	-
7	Pediastrum simplex	o	+	++	o	++	o	+	-	+	-	-	++
	Euglenophyta												
1	Euglena sp.	-	o	o	o	-	+	o	o	-	-	-	o
	Bacillariophyceas												
1	Cyclotella operculata	o	+	-	o	+	++	+	++	+++	++	-	++
2	Melosira carians	o	+	-	+	+	+	-	++	-	-	+	+
3	Navicula radiosa	o	+	-	o	+	+	+	++	+++	++	-	+
4	Pinnularia viridis	-	+	+	++	+	+	+	++	++	++	-	+
5	Nizchia linerria	-	++	++	+	+	-	-	-	-	-	+	-
6	N.vermicularis	-	++	++	+	+	-	-	-	-	-	+	-
7	Synedra affinis	+	+	-	+	+	+	+	++	+	-	+	++
8	S.ulna	-	++	++	o	-	-	-	o	-	-	-	-

TABLE - 28

MONTHLY VARIATION IN ALGAL POPULATION AT SAMPLING LOCATION 'I' (CITY AREA)

SN.	FAMILY / SPECIES	MONTHS											
		S	O	N	D	J	F	M	A	M	J	J	A
	Cyanophyceae												
1	Microcystis aeruginosa	o	+	++	+++	+++	+	++	++	+	+++	+	o
2	Anabaena constricta	o	+	++	++	+++	+	++	++	++	+++	++	+
3	Arthospira sp.	++	+	++	++	++	++	+	++	++	+	-	+
4	Merismopedia punctata	++	++	+	++	+++	+	++	++	+++	+++	++	++
5	Oscillatoria	-	-	-	-	-	-	-	-	-	-	-	-
6	Phormedium	o	++	o	-	+	-	-	-	-	+	++	++
	Chlorophyceae												
1	Chlamydomonas sp.	o	+	+	+	++	+	o	-	-	-	+	+
2	Chlorella vulgaris	+	+	+	+	-	+	+	+	+	-	++	+
3	Cosmarium	o	++	-	-	-	-	-	-	+	++	++	++
4	Scenedesmus-acuminatus	o	o	+	+	++	+	o	-	-	-	++	o
5	S. quadricauda	++	-	-	-	-	-	++	+	+	+	++	o
6	Spiroqyra	-	-	-	-	-	-	-	-	-	-	-	-
7	Pediastrum simplex	o	++	-	-	-	-	-	-	-	-	++	++
	Euqlenophyta												
1	Euglena sp.	-	o	+	+	o	-	o	o	o	-	-	o
	Bacillariophyceae												
1	Cyclotella operculata	++	o	-	-	-	-	+++	+	++	++	++	o
2	Melosira varians	+	+	+	+	++	+	++	+	++	-	+	o
3	Navicula radiosa	++	o	-	-	-	-	+++	+	++	++	++	o
4	Pinnularia viridis	-	o	+	+	+	+	-	-	-	+	++	-
5	Nizchia linerria	-	-	+	+	-	+	-	-	+	-	++	-
6	N. vermicularis	-	-	+	+	-	+	-	-	+	-	++	-
7	Synedra affinis	++	o	-	-	++	-	++	+	+	-	++	o
8	S. ulna	-	o	+	+	-	+	o	-	-	-	++	o

TABLE - 29

MONTHLY VARIATION IN ALGAL POPULATION AT SAMPLING LOCATION 'K' (MATATILA RESERVOIR)

SN.	FAMILY / SPECIES	MONTHS											
		S	O	N	D	J	F	M	A	M	J	J	A
	Cyanophyceae												
1	Microcystis aeruginosa	++	+	++	+++	++	++	+	+	+	+++	+	-
2	Anabaena constricta	++	+++	+++	++	+++	++	+	+	+	-	+	-
3	Arthospira sp.	+	+	+	++	++	++	+	o	+	-	+	+
4	Merismopedia punctata	++	++	++	++	+++	++	++	+	++	-	o	-
5	Oscillatoria	+	++	++	+++	+++	+	+	+++	+++	-	++	o
6	Phormedium	o	+	+	+	+	+	++	++	+	-	++	o
	Chlorophyceae												
1	Chlamydomonas sp.	-	+	+++	-	-	+	++	-	-	-	++	-
2	Chlorella vulgaris	+	+	-	+	+	+	++	+	+	-	++	+
3	Cosmarium	+	++	-	-	-	-	++	+	+	++	++	+
4	Scenedesmus-acuminatus	o	+	++	+	+	+	o	-	-	-	o	+
5	S. quadricauda	+	-	-	o	-	-	+	o	++	+++	++	+
6	Spiroqyra	+	-	-	o	+	+	+	+	++	++	++	+
7	Pediastrum simplex	+	++	+	-	-	-	+++	+++	-	-	++	+
	Euqlenophyta												
1	Euqlena sp.	-	o	o	+	+	+	o	o	o	-	-	-
	Bacillariophyceae												
1	Cyclotella operculata	+	-	-	o	-	-	+	o	++	+++	++	+
2	Melosira varians	+	+	++	+	+	+	+	o	++	++	-	+
3	Navicula radiosa	+	-	-	o	-	-	+	o	++	+++	++	+
4	Pinnularia viridis	+	+	+	++	-	-	+	+	+	++	+	-
5	Nizchia linerria	-	+	-	+	+	+	++	-	-	-	++	-
6	N. vermicularis	-	+	-	+	+	+	++	-	-	-	++	-
7	Synedra affinis	+	+	++	+	+	+	+	o	+	+	-	++
8	S. ulna	-	+	-	+	+	+	++	+	+	+	-	+

FIG - 4

MONTHLY VARIATIONS OF ALGAL POPULATION AT SAMPLING LOCATION 'E'

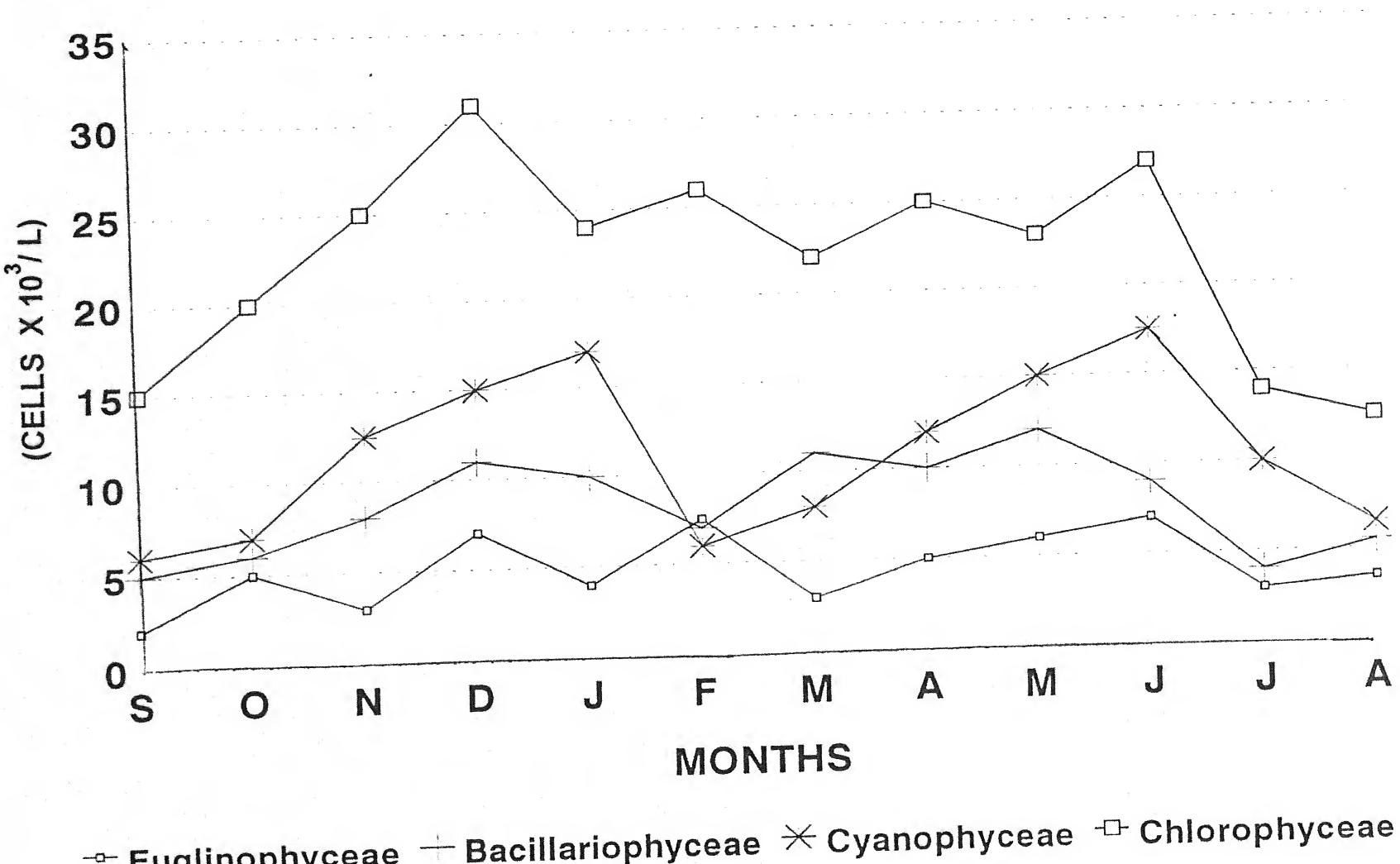


FIG - 5

MONTHLY VARIATION OF ALGAL POPULATION AT SAMPLING LOCATION `I'

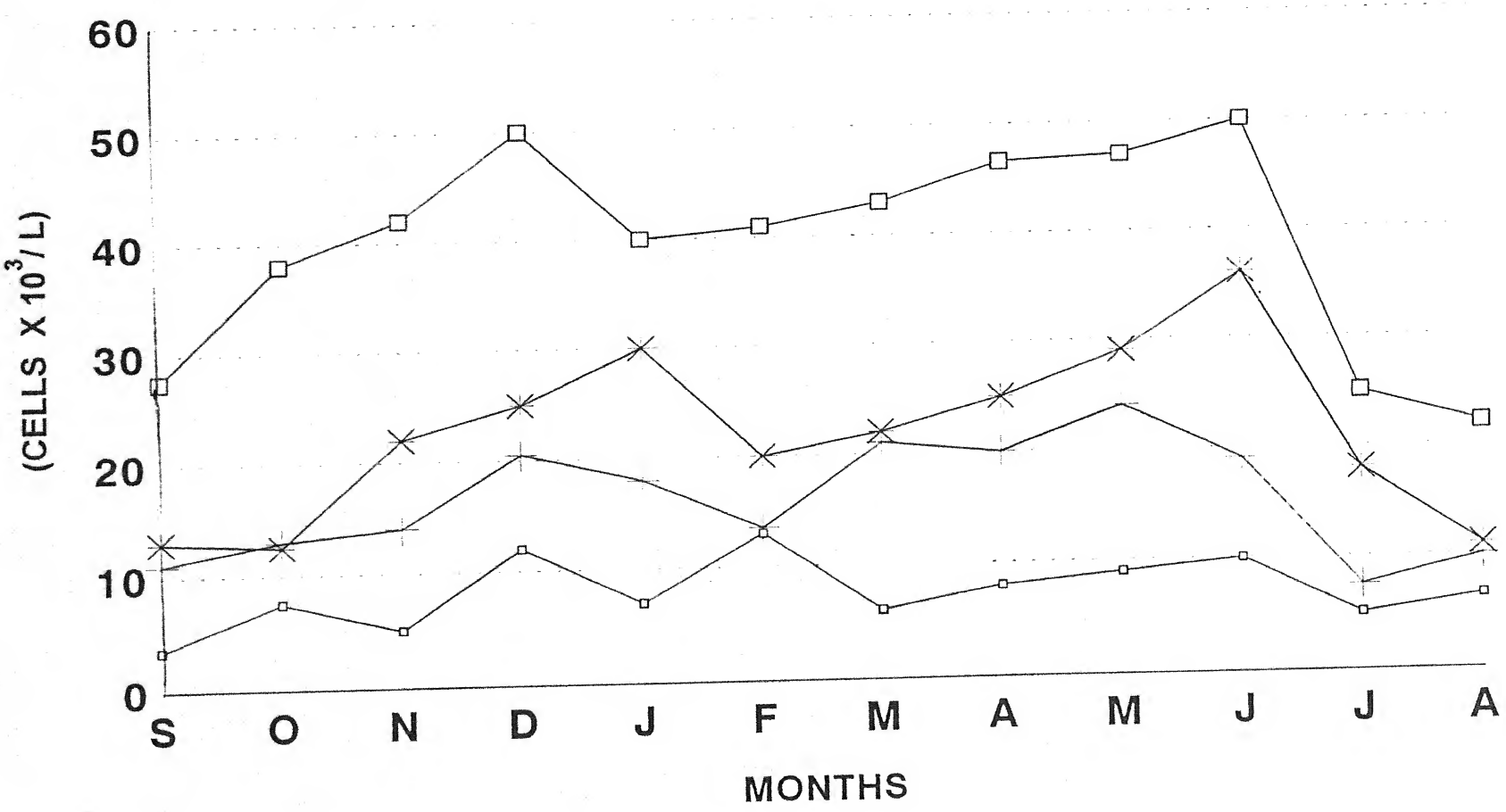
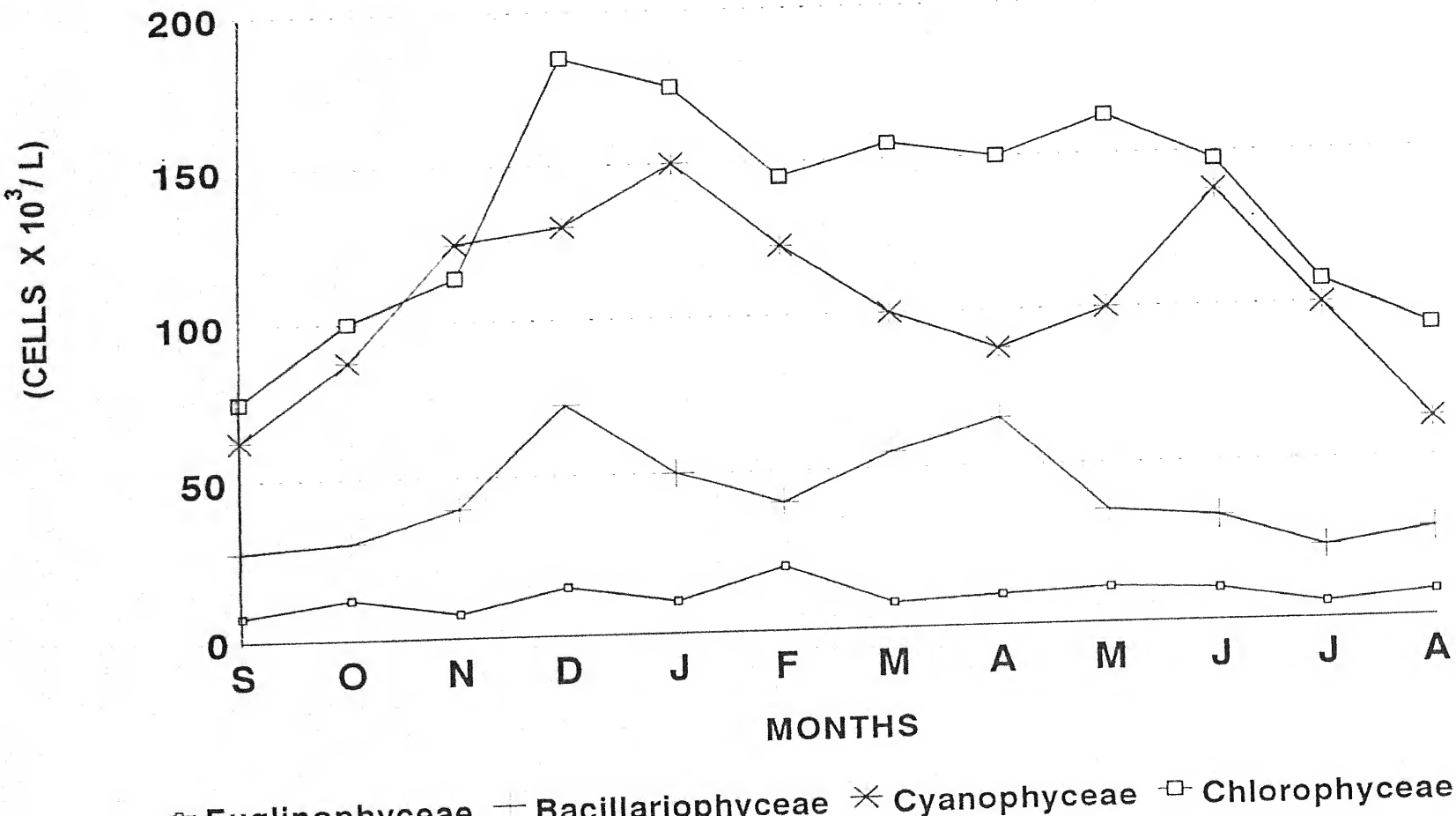


FIG -- 6

MONTHLY VARIATIONS OF ALGAL POPULATION AT SAMPLING LOCATION `K'



of blue green algal were found in late winter & summer seasons. In the present investigation, it was observed that chlorphyceal were dominant followed by Cyanophyceae, Bacillariophyceae & Euglenophyceae. Euglenoids showed more or less uniformity in their abundance. The general trend in increase of population can thus be arranged in the sequence of Euglenoid <Diatoms <blue green algae <green algae in all the 3 sampling location's.

The green algae were found throughout the year of which Chlamydemonas sp., Chlorella vulgaris, Scenedesmus quadricauda., Pediastrum simplex. were found to be most abundant. Among the Bacillariophyceae Cyclotella operculata., Melosira varians., Navicula radiosa., Pinnularia viridis. Synedra affinis. form the main bulk. Euglena remained fluctuating throughout the study period.

Good crop of algae population occured during winter and summer but lean during the rains. Chlamydomonas sp., were present in higher proportion during winter and rains where as Euglena were totally absent in the rainy season. During summer with the rise in temperature, the bulk of phytoplankton increased. With the initiation of rains there was a rapid falls in the number of phytoplankton possibly as result of dilution but by the end of July there population slightly increased. Among the Cyanophyceae, Microcystis aeruginosa., Oscillatoria, Anabaena were dominant.

During the winter season, the phytoplankton showed a heavy deposition at the surface of water in the reservoir during early morning but with the rise in sun and temperature the phytoplankton moved apart and were found homogeneously distributed. During winter the water remained clear and less turbid. However, there population was high due to the fact that they become homogenously distributed.

Cyanophyceae

Anabaena constricta - Filaments unbranched, short, spirally coiled with hyaline gelatinous sheath, remained around the air. Its highest population during summer. In dominence it was next to Microcystis aeruginosa. It exhibited the decreasing pattern during the May and a submaximum was noted in winter months.

Arthospira - Trichomes were multicellular, unbranched without sheath and showed regular spirals, large twits with fewer coils, terminal cells were usually larger. This algal showed its maximum population in the reservoir water but it as less frequent in the tap water's of Bada bazar (E) and City area (I).

Microcystis aeruginosa - Colonies were irregular, fre floating with an ildefined sheath. It was found dominant throughout the year at all the three sampling locations. Though, this algal was found to be dominant in the reservoir water but it did not resulted in causing the water bloom. This algal showed 2 maxima, one during summer it is June and another during winter it is December. The one which is occured in december, was larger than that of June. The algal showed a sharp declined in July and remained slightly low during the rainy season. With the onset of winter it started rapid multiplication and showed maximum development in December.

Oscillatoria sp. - Single unbranched trichome with the thin, watery, less form sheath, which could be observed with chloro - Zinc - iodide reagent. It appeared scattered in the month of July but soon became dominated during rains and winter throughout the reservoir water. In February its population declined after which it disappeared and remained abent throughout the summer.

Phormidium - These trichome were in appearance similar to Oscillatoria but the filaments were often found agglutinated with one another and trichomes do not dissociate easily. Mostly the algal was rare in tap water supply. It also showed the similar trend like that of Oscillatoria.

Chlorophyceae

Chlamydomonas sp. Unicelluar; motile, spherical - oval with two anterior flagella; cup - shaped chloroplat with one or more pyrenoid and a single nucleus. Its presence was noticed in all the sampling locations. It appeared in the month of June and its number increased progressively till August. In September it showed a declined and totally disapeared in winter and summer.

Chlorella vulgaris : It is a solitary; free floating; spherial algal with thin and smooth wall; chloroplast single parietal; cup-shaped or laminate with or without pyrenoid. It was found associated with Microcystis aeruginosa and

Scenedesmus quadricauda. It appear in June after the first shower increased in number during the rainy season. Its maximum number was recorded in the month of July and August.

Cosmarium sp. : Cells compressed oval to spherical with a deep medium construction, length slightly greater than breadth. Cell wall smooth, each semicell with single axial chloroplast with 4 radiating plate's pyrenoids axial in position. Its presence was occasional & the percentage was less throughout the study period.

Pediastrum simplex : Colonies were stellate, free floating with 16 to 64 polygonal cells arranged in a single layer; marginal cells has single projection; chloroplast single parietal with pyrenoid. This algal has been found in association with other algal forms and at all the sampling location's. It was present throughout the year. The lowest density of its populations was recorded in summer and rarely high in rainy and winter season.

Scenedesmus sp. : The coenobium of Scenedesmus consisted of 4 cells arranged in a single layered flate plate, with a long axis parallel to one another; cell wall smooth with lateral spines on the outer most cells. Chloroplast single, laminate with a pyrenoid. The algal was found associated with Chlorella vulgaris and another species of Scenedesmus. Its occurrence exhibited 2 peak periods one in September and the other in March. It has been found to be present throughout the year at all samling locations. Its distribution was less during the onset of summer but with the onset of rains its number began to increase and reached to the maximum in winter.

Spirogyra: It comprises of multicelluar, unbranched filament with a mucilagenous sheath of pactoge. There is no distinction of base and apex and all the cells were alike with in the filament. This algae was often associate with Chlorella vulgaris. It appeared in the month of October at the reservoir sampling location. Its number increase considerable during winter. It began to decrease and finally disappear in the summer season but rare occurrence was noted in rainy season. It was absent in tap water supply sampling location's.

Euglenophyceae

Euglena sp. : Cells unicellular, fusiform to acicular, constantly change their shape; and posterior and more or less pointed; gullet and eye spot anterior, chloroplast many, pyrenoids present, uniflagellate. It appeared in the month of November and multiplied rapidly in March and April. Even it presence was recorded in the month of June. It occured in a compatatively low frequency at all the three sampling location's.

Bacillariophyceae

These formed the largest bulk of phytoplankton. They were formed through out the year. These lean population was recorded during rainy season followed by an upward trend in the winter. It showed 2 peaks, one in the summer and the other in the winter. A total number of 8 member's have been recorded. Its representations waas made mainly by Cyclotella operculata, Melosira, Navicula radiosa, Pinnularia viridis and Synedra affinis.

Cyclotella operculata : Cells usually solitary, girdle unsculptured; valves circular, ornamented in two seaons, outer peripheral radially costate, inner smooth and irregularly punctate; chromato phores many and discoidal. It was present through out the study period and showed higher number in winter and summer. It was collected from all sampling locations.

Melosira varians :Cells united to form unbranched filaments; girdle sculptured; valves circular; ornamentation in 2 parts; chromatophores many, disc - shaped. Occured though in low proportion but was found in all locations with greater abundance in reservoir water specially during winter month's.

Navicula radiosa : Consist of symmetricaly frustules, rectangular in girdle view; raphe and axial field straight, latter is narrow without any expansion, lateral to axial field striae in transvere rows; stauros absent. This deatom showed 2 peaks of occurrence, one in the month of June and the othe in December. From July its number began to declined throughout the rainy season.

Nitzschia sp. : Frustules with transverse septa; usually elongated and poses straight and sigmoid valves with variable outline, valves and raphe are

diagonally placed. The valves have small, central, polar module. This diatom also showed 2 peaks.

Pinnularia viridis : Frustules are symmetrical; axial field broad and expanded next to the central and polar nodules; raphe to the somewhat sigmoid or straight outer fissure; valves with smooth transverse costal; rectangular in girdle view; girdle smooth without intercalary bends. This diatoms showed 2 peaks of occurrence, one in June and the other in December. It declined with the approach of rains and remained in low frequency during rains.

Synedra affinis : Frustules usually narrow, many times longer than broad, solitary or in radiate fan - shaped, fre floating forms; needle shaped in both views; valves linear to lanceolate, straight to curved; pseudoraphe and transverse ornamentation present; apices truneate in girdle view; bilaterally symmetrical in both views. This diatom was generally found, associated with Navicula & Pinnularia. It also showed high frequency during summer & winter months with 2 peaks, one in winter and the other in summer remained low during the rainy period and was found at all sampling locations.

Chapter - B

Bacteriological Study

The water used for domestic purpose is obtained from surface sources i.e. rivers, stream's, ponds & lakes. Such natural water supplies are likely to be polluted with domestic and industrial wastes. We are aware that a considerable portion of it, at some earlier stage, has already been used domestically or industrially. Municipal water - purification system have to play an important role in protecting the inhabitants against polluted water. At the same time, as popularion centers grow, pollution problem become more serious. A greater quantity of water is required and the used water must be disposed of generally by returning it to a natural body of water in the vicinity, which in turn may be a water supply source of another community. As such a a potential carrier of pathogenic microorganisms, water can endanger health & life.

As soon as the raindrops of slow touch the earth they become contaiminated by microorganisms in the soil. These are then known as surface water's. The extent of contaminations is dependent upon the number of organisms in the soil of also upon the kinds and quantities of food materials of the soil or domestic waters. The bacterial count of surface water are thus to show great variations. This is particularly true in the seasons of heavy rains and melting snows. The wash off from the surface upset the existing equilibrium in the surface water's, upset the existin equilibrium in the surface waters, resulting in considenrable variation in the flora and bacterial contents. The first result of mild rain is to greatly increase the bacterial contamination of a body of water. A prolonged rain exerts an opposite effect owing to the fact that after the main impurties have been removed from the upper layer of the soil, the subsequent rainfall acts merely as a diluent of the body of water.

In storage tanks at filteration plants the number of organisms decreae. The forces which produce bacterial self purification now comes into play. These are sedimentation, activities of other organisms, ultra bacteria have a specific gravity slightly, greater than water. which means that they will slowly

settled in a standing body of water. However, the greatest factor responsible for sedimentation of bacteria in there attachment to suspended particles. The suspended particles in settleing mechanically remove the organisms from the upper layer of water. In at Matatila reservoir the organisms settle down to a great depth and thus they forms zone's of saprobity. The lowest most is the polysaprobic zone. Where, bacteria mostly anaerobic bring about putrefaction and fermentation. Thus at this zone the number of bacteria are maximum because of these settling with suspended particles above this zone is the 'mesosprobic' zone where mineralisation of organic substances with intense oxidation & nitrification takes place. Here the number of bacteria are markly less than those of the lower layer. The surface water or the oligosaprobic zone is having further reduce number of bacteria.

Bacteriological analysis involved in the present study, is the plate count method by which, we could count the total number of organism present in water. These are expressed in the(table - 30) which show number of bacteria, per ml. of sample and are designated standard plate count at 35 ^{0} C. Various factors influence the number of colonies developing on agar medium that is composition of the medium, temperature and period of incubation, presence of moisture, oxygen etc. satisfactory precaution were taken to control these factors but still we could concluded that the results shown in the table - 30, are fraction of the total count as nitrifying, autotropic bacteria, an aerobic and parasitic form would have not been grown, the result is that most of the bacteria must have a escaped detection to eliminate these short comming we used different medias and temperature. That is eosin - methylene - blue agar, Mac konkey broth, nutrient agar etc., and the incubation temperature were maintain at 35 ^{0} C $\pm$ 0.5 ^{0}C and 20 ^{0} C $\pm$ 0.5 ^{0} C for 24 to 48 hours. It was observed that the average total viable count varied from 2.0 x 10^2 to 340 x 10^2/ml at different sampling locations of the tap water supply. It was found that the total count of bacteria dropped during the winter months ataining these lowest values and during summer months the population increased and attend peak values during May or June, i.e. lowest in winter and highest in summer.

TABLE - 30

MONTHLY VARIATIONS IN TOTAL VIBLE COUNT OF BACTERIA PER ML. AT DIFFERENT SAMPLING LOCATIONS

SN.	MONTHS/YEAR	NAME OF THE SAMPLING LOCATIONS										
		A	B	C	D	E	F	G	H	I	J	K
1	SEPT. 1995	$25X10^2$	$35X10^2$	$80X10^2$	$70X10^2$	$90X10^2$	$62X10^2$	$40X10^2$	$59X10^2$	$91X10^2$	$20X10^2$	$90.5X10^3$
2.	OCT. 1995	$10X10^2$	$18X10^2$	$30X10^2$	$25X10^2$	$35X10^2$	$60X10^2$	$35X10^2$	$46X10^2$	$45X10^2$	$16X10^2$	$40X10^3$
3.	NOV. 1995	$9X10^2$	$15X10^2$	$17X10^2$	$12X10^2$	$26X10^2$	$30X10^2$	$30X10^2$	$22X10^2$	$29X10^2$	$12X10^2$	$19X10^3$
4.	DEC. 1995	$7X10^2$	$8X10^2$	$9X10^2$	$3X10^2$	$18X10^2$	$26X10^2$	$8X10^2$	$12X10^2$	$19X10^2$	$2X10^2$	$10X10^3$
5.	JAN. 1996	$6X10^2$	$2X10^2$	$6X10^2$	$7X10^2$	$8X10^2$	$2X10^2$	$11X10^2$	$7X10^2$	$10X10^2$	$14X10^2$	$11X10^3$
6.	FEB. 1996	$20X10^2$	$15X10^2$	$9X10^2$	$40X10^2$	$21X10^2$	$20X10^2$	$29X10^2$	$46X10^2$	$29X10^2$	$25X10^2$	$20.3X10^3$
7.	MAR. 1996	$80X10^2$	$38X10^2$	$91X10^2$	$90X10^2$	$196X10^2$	$100X10^2$	$93X10^2$	$102X10^2$	$100X10^2$	$80X10^2$	$148X10^3$
8.	APR. 1996	$102X10^2$	$115X10^2$	$100X10^2$	$185X10^2$	$200X10^2$	$195X10^2$	$106X10^2$	$140X10^2$	$150X10^2$	$100X10^2$	$175X10^3$
9.	MAY. 1996	$119X10^2$	$150X10^2$	$140X10^2$	$200X10^2$	$295X10^2$	$221X10^2$	$200X10^2$	$160X10^2$	$220X10^2$	$189X10^2$	$257X10^3$
10	JUN. 1996	$200X10^2$	$210X10^2$	$220X10^2$	$205X10^2$	$125X10^2$	$225X10^2$	$216X10^2$	$260X10^2$	$340X10^2$	$205X10^2$	$232X10^3$
11.	JUL. 1996	$85X10^2$	$120X10^2$	$180X10^2$	$100X10^2$	$100X10^2$	$195X10^2$	$110X10^2$	$129X10^2$	$125X10^2$	$80X10^2$	$112.5X10^3$
12.	AUG. 1996	$40X10^2$	$50X10^2$	$78X10^2$	$78X10^2$	$96X10^2$	$75X10^2$	$80X10^2$	$70X10^2$	$100X10^2$	$40X10^2$	$98X10^3$

At sampling location 'A' total viable count increased from February to June then there was a sharp fall from July to January. The lowest value of 6.0 x 10^2 was obtained in January, where the highest value of 200 x 10^2 was noted in June.

At sampling location 'B' we got the same trend that is rise in the total count from february to June and then a sharp decline from July ataining a minimum value in January. The lowest value of 2.0 x 10^2 was noted in January when the highest value 210 x 10^2 was noted in June.

At sampling location 'C' through the minimum and maximum value were obtain in the same months of January & June respectively. From July to September, there was a sharp fall in the total count but in the October suddenly in the number flared up which again subside from November to January.

At sampling location 'D', we noted the same trend as observed in location A & B. However the minimum value was obtain in December 3.0 x 10^2 and maximum value in June that was 205 x 10^2 thus there was a rise in total count from January to June and then decreased from July to December.

At sampling location 'E' the minimum value of 8.0 x 10^2 was noted in January in May instict of June as observed at other location's. There was a rise from february to May and then decreased from June to January.

At sampling location 'F' the trend was similar to A & B. That is minimum vaalue of 2.0 x 10^2 in January and the highest value of 225 x 10^2 in June. Gradual rise in the summer months there after decrease from rainy season to the winter season.

At sampling location 'G' the trend was similar to that of 'D' where the minimum vaalue of 2.1 x 10^2 was in December and the maximum value of 216 x 10^2 in June. The same trend was noted at the sampling location 'J' that is the minimum value of 2.0 x 10^2 in December and the highest value of 205 x 10^2 in June.

At sampling locations H & I the trend was similar to that of A, B, & F, that is the minimum values in January & maximum value in June. The rise was noted during summer month and decline from fall to the winter months.

At sampling location 'K' the values were quite high as compare to those of the other sampling locations of the tap water supply. However the trend was the same that is the minimum value in January & maximum value in June. The rise and decline followed the same trend, i.e. higher during the summer and low during the rainy and winter seasons. It appears that the number of organisms in tap water supply declined due to sedimentation, filteration & chlorination.

Plate count are useful in determining the quality of water as water of good quality is expected to a low count. It is also useful in determing the efficiency of operation for removing or organisms at the filteration plant and these such counts can be made before and after specific treatments for example sedimentation, filteration and chlorination. The results indicates the extend to which microbial population have been reduced.

From the sanitary point of view it is more important to know that the pathogenic organisms present in water which are rapidly growing. Food loving bacteria found in sewage because water with the few pthogenic bacteria is obviously more dangerous then water containing many saprophytic bacteria. The most important disease transmitted by water are typhoid, discentry & cholera. Since these are intestinal disease the causative organisms are found in feces. Therefore, the presence of sewage in a water supply means that one or more of these disease organisms may be present and thus the wate becomes dangerous for human consumption. Theoriticaly it appears better to examine water for the presence of disease organisms to determine its sanitary quality but such a procedure is not recommended as a routien practice. The techniques available are complicated and time consuming so that the results when obtained would lose much of its significance and might even be confusing in a particular study of pollution. Therefore, the method it was followed by the present author was not to detect isolate or inumirate pathogenic bacteria in water but was intended to indicate the degree of contamination with wastes from human and animal sources and thus the group of bacteria known as coliform were detected. Since, coliform organisms particulary E. coli are constantly present in human intestine in large number

TABLE - 31

MONTHLY VARIATIONS IN TOTAL M.P.N. COUNT OF BACTERIA / 100 ML. AT DIFFERENT SAMPLING LOCATIONS DURING THE STUDY PERIOD

SN.	MONTHS/YEAR	NAME OF THE SAMPLING LOCATIONS										
		A	B	C	D	E	F	G	H	I	J	K
1	SEPT. 1995	29	27	34	32	35	29	27	29	39	29	290
2.	OCT. 1995	19	26	21	24	28	27	24	21	28	19	540
3.	NOV. 1995	16	19	24	17	28	26	22	17	24	16	430
4.	DEC. 1995	15	16	20	16	21	24	17	19	21	15	290
5.	JAN. 1996	12	15	13	19	19	20	19	17	19	19	240
6.	FEB. 1996	24	20	19	20	23	24	22	21	20	21	210
7.	MAR. 1996	34	36	34	31	35	37	36	31	42	29	350
8.	APR. 1996	42	37	39	37	45	47	48	48	54	37	920
9.	MAY. 1996	64	75	76	79	84	81	79	67	95	64	1600
10	JUN. 1996	95	120	130	140	160	150	150	140	210	110	2400
11.	JUL. 1996	39	42	53	58	79	76	58	47.5	84	39	540
12.	AUG. 1996	27	29	32	31	34	33	27	34	37	27	240

and billions of these are excreated by an average person in one day. Secondly, these organisms live longer in water then intestinal pathogen too. Thus the presence of coliform in water was regarded as a warming signal for potentially dangerous pollution. Coliform group include all aerobic and facultative aerobic, gram negative, non - spore forming, rod - shaped, bacteria. Which ferments lactoe with the production of acid & gas within 48 hours at 35^0 C. The method of its isolation, presumption, confirmation and complete test has been described in mateials & methods under the section - 2. The sample's were analysed within one hour after collection as the bacterial number increase by increase in temperature. Most probable number of total coliform bacteria was done by multiple tube method (APHA 1976) for presumptive test lactose broth was used and confirmed in brillient green lactose broth with complete test in eosin - methylene - blue medium. The results obtained are shown in table - 31.

It was observed that average count of the coliform bacteria in tap water supply varied from 12 to 210 cells per 100 ml. at different sampling locations. In the reservoir water the average count was quite high and ranged from 210 to 2,400 per 100 ml. The coliform count were low in winter months. The lowest value in the months of December & January and highest in the month of June. The values constantly increased during the summer, low during the mansoon and lowest in the winter. Temperature favoured the development of coliform counts higher temperature faroured the growth where, lower temperature retarted the growth and multiplication of coliforms. During summer with the rise in temperature there was an increase in the coliform counts. While during winter with the decrease in temperature the coliform counts also decreased. This showed the positive influence of temperature. The growth at higher temperature dipict a typical mesopytic character of the coliform.

At sampling location A,B,C,E,F, H & I the lowest count were obtained in January while the highest count in June. At sampling location D, G & J the lowest count was in December. At Matatila reservoir that is K, the lowest count was in February.

The mark reduction in the MPN count of bacteria in tap water as compared to reservoir water could again be due to sedimentation filteration & chlorination at the filteration plant.

Coliform count include all non spore forming aerobic & facultative, anaerobic, gram - negative, rods that produce acid & gas from lactose. Under this group all species of the genera Escherichia & Aerobacter. Aerobacter in generally of soil or plant origin but as high as 10% of the faecul sample may be found. To harbour these organisms Escherichia is considered to be primarily of feacal origin. The intenraction of the two or more species of the bacteria yield acid & gas from lactose due to syneragism for this reason confirmed and complete test were performed. IMViC tests, in which Indole test, methyl red test Voges - Proskauer test and Citrate test were also performed. It was found that the sewage E. coli appeared only at occasional intervals. Specially at the sampling locations E, I & K. Their number at occasions were enough to give the indication of pathogenic pollution. Specially during the summer months. And occasionaly in one or two samples during the onset of winter that is by the end of June.

SECTION - 6

DISCUSSION & COUCLUSSIONS

SECTION 6

DISCUSSION AND CONCLUSIONS

Microbial and physico-chemical variation in tap water supplies of Jhansi have great significance in problems of human welfare. For tackling these problems a thorough ecologial data is necessary. Tremendous increase in population, advance agricultural & industrial practices, impoper waste disposal and over exploitation of resources has further deteriorated the quality not only of tap water but also of under ground water specially during the summer months. It was in this background that the present investigations were undertaken to collect relevant data's on physico-chemical and microbial variations in tap water supplies of Jhansi town in Uttar Pradesh.

Jhansi the famous patriotic city of Laxmibai is situated at 25^0-27' North and 78^0-35' East. It is about 271 metres above mean sea level. The population of about 3.5 Lac's has potable water supply of 27.0 mld. Out of which 9.5 mld. Comes from Matatila reservoir through Babina filter plant, 13.6 mld from Pahuj reservoir through Datiya Gate filter plant and about 3.910 mld. From tube wells through pipe line distribution system extended to a length of 371 km. The town faces acute water scarcity mainly because of low & erratic rainfall, high run-off & rocky terrain with low infilteration capacity and limited retention. Due to which availability of ground water is very much limited & unreliable. The requirement of water is 69 mld. Which is much less than the supply of 27.01 mld. (Map - 1 & II).

The study area extends form L..har Temple outside Datiya gate, Unnao gate in the North to Nagra, Puliya No. 9 and Cantt in the south and Pahuj Dam in the East to Narain Bagh Medical College in the west. The prosent investigations were carried out form september 1995 to August 1996. During which fortnightly samples were collected during 10 to 11 A.M. from 12 sampling locations stationed widely so as to obtain samples of different localities. These are maked from A to L. The work was carried out to understand seasonal variations of

various physical, chemical and biological properties viz. Odour, taste, colour, temperature, electrical conductivity, pH value, chloride contents total hardness, total Alkalinity, Carbonate contents, bicarbonate contents, free carbondioxide, total carbondioxide, dissolved oxygen, biochemical oxygen demand, phytoplankton and bacteriological variations. From the observations made on the above factors conclusion and suggestive control have been derived.

The physico-chemical conditions of water play a supreme role in determining the living complex; which is largely the result of their interactions and inter dependence. Climate of Jhansi can be divided into three season's i.e., winter, summer & rainy. These three seasons have marked influence on the biological community in aquatic environment. The impact of monsoon brings radical changes in the physicochemical conditions as well as the depletion of microbial and planktonic community by mixing up of water. Seasonal variation's by themself have a direct effect on aquatic biology, these together with turbidity add to the intricacy to the processes going on. High turbidity may be due to various reason's. It depicts high productivity when produced by plankton populations, however, when it is due to organic and inorganic materials brought in by surface runoff in rainy reason results in low population. These observations are in full accord with planktonic counts and also with other properties which control their growth and multiplication.

The author found earthy and musty odour during summer & most of the rainy season at 5 sampling locations. Most of the bad odour in drinking water is due to organic substances present in the solutions or suspension or due to microscopic organisms (Balsare et. At. 1981). The vegetable odour are caused by deompositions of organic matter other than the living organisms were grassy on fishy. In water supplies at times the odour was caused by chlorine or chlerination compound due to excess of chlorine. Although it kills the microorganisms the hallogenated compound produced by its relations with the organic matter are carcinogenic. In small amount chloroforms is also formed, but

its limit shoud not exceed 100 ppb. Otherwise it may cause kidney tumour (Balsare 1991).

Earthy or musty tastes & odour in drinking water may be due to actinormycetes rendering it unpotable. The major difficulty in its preventing measures in water supply is the prevalance of earth or musty odour in the summer and rains rather than winter as noted by the author seems to be due to the temperature which is the prerequisite for their production. The odour problem was observed from the water sample obtained from tap water rather then tube well water. It appears that the plant litter and animal debris on the reservoir banks serve as a source of substrate for streptormycetes growth and geosmin production. These observations of the author are in accord with the observation of silvery & Roach 1975; William et. al., 1984; Wood et. al., 1985. Actinomycetes were detected by the author during bacterial sampling. The spores of actinomycetes are relatively resistant to chlorination treatment hence possibly occur in distribution system. The occurance and significance of actinomycetes in water supply such as river water, stored water, slow sand filter, biological sludge blankets, chlorinated water & the distribution system has been reviewed by Burman 1973.

Transparency or colour has a direct bearing on the light penetration of water & depends upon suspended matter and dissolved coloured particles, some times surroundings. It is caused by the substance which are not present in the form of true solution. It is actually the expression of optical property in which the light is scattered by the particles present in water. Turbidity makes the water unfit for domestic purposes, food & beverages industry & many other uses. (Ajmal & Razi-ud-din 1988). Saxena et. al., 1966 obscrred highest value in river ganga at kanpur during rainy season due to the surface run-off, high velocity of current & other impurities. In Kali-Nadi; the maximum turbidity was noticed in summer by Ajmal & Razi - ud- din 1988. Author noticed turbidity at some sampling locations during summer & rainy months.

Temperature effects the seasonal and diurnal variation. It enhances all

biochemical & biological reactions including growth, multiplication , respiration. decay, mineralization, production etc. It enhances both phytoplankton and bacterial species composition, density, frequency & succession together with the changes in the chemical environment. Water temperature was found to be minimum 14^0c. After June the temperature gradually decreased thorughout the rainy & winter season aproaching minimum value in January. Then again gradually increased during February, March, April, May & ultimately reached the maximum value during June. During monsoon season temperature ranged from 21^0C to 38^0C . In winter season the temperature has a narrow range of variation from 17.3^o to 24^0C while during summer season a maximum peak of temperature ranged from 19^0C to 39^0C was recorded. Temperature depends upon the season, time of sampling and temperature of effluents being added. Heat inflow income results form several process like direct absorption of solar radiation (dominent source) transfer of heat from air, condensation of water vapours at the water surface, transfer of heat from sediments to the water, heat transfer from terrestrial sources i.e., metal pipelines, precipitation surface runoff and ground water inputs. Heat losses may occur due to specific condition of heat to the air and to a losses extent to the sediments, evaporation and out flows expecially of surface water. This input / output phenomenon of heat is generally i.e., the total amount of heat necessary to raise the water from minimum temperature of winter to the maxumum summer temperature form the stand point of the whole aquatic body (Malin K. Shastree 1991)

During the present investigation pH ranged between 6.89 to 8.00 Maximum values were found during june. pH is an important factor in the chemical and biological systems of the natue water. The maximum values were recorded during summer season and comparatively low values during winter & monsoon months. Similar trends have been reported by Gupta & Mehrotra 1986. Fluctuations in the pH have also been observed with reference to sampling sites. pH of water could be correlated with the intensity of pollution as was found

durind studies on bacterial phytoplanktonic count. Similar observation were made by Verma et . al. 1984 & Saxena et. Al., 1966.

Results obtained are statistically analysed season wise for temperature and pH. These are given in the table 32 & 33 in which Standard deviation, Standard error & mean variability have been shown.

The author has observed a low conductivity profile in winter months & high levels of the same in summer months at all sampling locations. The seasonal variation in the conductivity value is mostly due to the increased concentration of salts because of evaporation; the dilution resulted form precipitation brings down its values. There observation are in accord with those of Trivedi et. al., 1985. High levels of conductivity appears to reflects on the pollution status as well as trophic levels of the aquatic body, conductivity is good and rapid measure of the total dissloved solids. In present study the highest conductivity upto $7.2x10^3$ micromhos was noted at sampling location E in the month of July (Table -15). Higher values were recorded in tube well waters as compared to tap water supplies of the reservoirs. This indicated a higher proportion of dissolved solids in tube well waters at sampling location L. Occasional higher values obtained at location E&I of tap water indicate that some tube well water must be suplied or mixed up during the supply at specific occasions.

Chloride contents of tap water supplies of Jhansi town was having an abnormally high range i.e. it varied from the minium value of 16.0 mg/L to the maximumm value of 133.0 mg/L. In general the minimum values were obtained during September November and the maximum values during the month of May or June. Chlorides in the form of Cl^- ions is one of the major inorganic ions in water and waste water. In potable water the salty taste produced by Chloride concentrations is variable and depends on the chemical compositions of water. The Chloride concentration is higher in waste water then in raw water because Nacl is the common salt of the diet and passes unchanged through the digestive system Chloride influential in general osmotic salinity balance and ion exchange,

but metabolic utilization may not cause significant variations in the spatial and seasonal distribution within an aquatic system. However pollution Vig. Municipal waste water, from industrial sources etc. can modify natural concentrations greatly. It can be said from our observations that these was so definite pattern of chloride fluctuation. The variations may be due to precipitations, evaporation, humen activity or municipal waste. Ajmal et. al., 1985, found maximum value of chloride 98.5 mg/L during winter season & minimum value 2.0 mg/L during summer season in Kali Nadi. Our observation are quite contarary as we found maximum value in summer & minimum during the winter season. Similar results were obtained by Gupta & Mehrotra 1991 & Khan 1981. Higher values indicate high pollution load. This observation of the author are in accord with those of Palharya & Malviya 1988; Rana & Palharya 1988. As such high amount of chloride gives a possible indication of the source of sewage drains opening into pipelines leading to certain sampling locations specially E&I. Where frequently high values were obtained. Better understanding of these results can be obtained in seasonwise statistical analysis of the datas in table-35.

Total hardness in the tap water of Jhansi ranged from a minimum vaue of 104.0 mg/L to the maximum value of 586.0 mg/L. Water hardness was understood to be a measure of the capacity of water to precipitate soap. It is defined as the sum of calcium and magnesium concentration and expressed in mg/L. It depenes on the source and treatment to which the water has been subjected. We could not find any definite pattern of total hardness.

Total Alkalinity generally showed a higher value during summer month & low during winter month, similar observation were obtained by Gupta & Mehrotra 1991 & Nalin k Shastree et. al. 1991. It varied from its minimum value of 96.0 mg/L to a maximum value of 430.0 mg/L. Bicarbonate alkalinity gave positive results while hydroxide gave negative results. Carbonate alkalinity could be detected occasionally & that too in a very few sampling locations (Table - 20) and was only upto a maximum value of 56.0mg/L. Alkalinity over 150mg/L has been found to be conductive to higher produciton (Ball 1949). Our most

observations reflect the good productive nature. Rise in total alkalinity in warmer months may account for the depletion in water level (Saha & Chaudhary 1985 & Dudeni et. al., 1986). Saxena et. al., 1966 observed 465.0 mg/L alkalinity in river Ganga at Kanpur.

Bicarbonate contents varied form 82.0 to 430.3 mg/L generally high during summer months Table-21. Somasheker 1984 has observed that bicarbonate alkalinity is mainly responsible for higher value of alkalinity in river Cauvery.Higher values of bicarbonate during summer suggests mixing of effluents.

Free Co_2 during the investigation period ranged between nil to 31.68 mg/L. During the entire period of study values obtained at sampling location I were higher as compared to other sampling locations. It was generally having a maximum value during May or June at all sampling locations. The author found a direct correlation between free Co_2 and bicarbonate alkalinity these observations are in accord with the observations made by Mandal & Hakim 1975 in a fresh water pond at Bhagalpur & Nalin K. Shastri et. al., 1991 at Ravindra Sarovar Gaya. We have also observed a fall in the amount of total alkalinity & free Co_2 during early monsoon as compared to summer months specially May & June when we observed the highest values. These may be due to monsoon showers which resulted in the dilution of water. Similar observation were of Michael 1969 & Nalin K. Shastri et. al., 1991 free carbondioxide is generally high in polluted waters (Mishra & Saxena 1991, Verma & Dalela 1975) Its higher values obtained by the author at sampling locations E. H & I bring such locations under suspision. Presence of bicarbonate alkalinity can be explained on the basis of amount of equlibrium Co_2 in water which inhibits conversion of bicarbonates into carbonate (Munawar 1970, Ruttner 1953) while the increase in bicarbonate in other reasons can be attributed to the decrease in pH which changes insoluble carbonate into soluble bicarbonate (Kollman & Woli 1976).

Total Carbondioxide's contents of tap water at Jhansi showed a range between 91.0 Mg/L to 8415.0 Mg/L .The Minimum value was observed in

TABLE - 32
STATISTICAL RESULTS OF TEMPERATURE

S. No	SAMPLING LOCATIONS	NAME OF THE SEASON'S								
		SUMMER SEASON			RAINY SEASON'S			WINTER SEASON		
		S.D.	S.E.	Mean ± variability	S.D.	S.E.	Mean ± variability	S.D.	S.E.	Mean ± variability
1	A	7.497	3.35	32.3±5.63	6.066	2.71	30.6±3.92	3.008	1.34	18.9±1.96
2	B	7.829	3.501	30.4±6.48	6.47	2.89	30.0±4.36	2.49	1.11	19.2±1.76
3	C	9.094	4.067	31.2±7.76	3.96	3.11	30.0±4.8	2.39	1.07	17.8±1.84
4	D	8.65	3.87	30.6±7.28	6.54	2.92	29.6±4.48	2.41	1.08	18.12±1.65
5	E	7.86	3.51	30.6±6.48	6.14	2.74	29.8±4.16	2.4	1.07	19.3±2.04
6	F	8.02	3.59	32.4±6.72	7.03	3.15	30±5.2	2.8	1.24	19.2±2.16
7	G	8.25	3.69	31.5±6.66	6.05	2.70	29.4±4.53	2.65	1.9	17.9±1.92
8	H	7.94	3.55	31.8±6.65	4.80	2.147	30.8±3.38	3.27	1.46	19.8±2.24
9	I	8.29	3.708	31.1±6.54	5.81	2.6	29.7±4.14	2.34	1.05	18.5±1.8
10	J	8.34	3.72	32.0±6.8	6.65	2.98	29.4±4.9	1.34	0.6	19.4±1.12
11	K	7.31	3.27	27.6±6.00	3.52	1.58	28.6±2.45	2.65	1.2	19.64±2.17

TABLE-33
STATISTICAL RESULTS OF ELECTRICAL CONDUCTIVITY

S. No.	LOCATIONS	NAME OF THE SEASONS								
		SUMMER SEASON			RAINY SEASON			WINTER SEASON		
		S.D.	S.E.	Mean±Variability	S.D.	S.E.	Mean±Variability	S.D.	S.E.	Mean±Variability
1.	A	1934.807	865.2722	2436±1678.8	1722.0	770.1	1020±1232	23.57	10.1475	243.4±18.08
2.	B	1819.8	813.8	3276±1198.4	2127.2	951.3	1195±1522	10.60	4.74	250±8.0
3.	C	1446.8	647.04	2692±1009.6	1585.4	709.0	694.4±1134.2	15.16	6.782	249±11.2
4.	D	1439.4	643.72	2724±1001.6	1358.9	607.73	869.4±972.24	24.89	11.153	233±19.6
5.	E	2623.5	1173.28	5260±1864	3396.2	1518.8	3046±2963	24.49	10.95	590±20
6.	F	1555.7	695.7	2964±10976	1276.7	570.9	81.2±913.52	24.49	10.95	590±20
7.	G	1456.2	651.2	2712±1065.6	1369.8	612.63	850±979.91	9.08	4.06	238±6.4
8.	H	1947.7	871.06	3566±1200.8	2461.0	1100.6	1506±1757.6	36.33	16.248	602±25.6
9.	I	2547.2	1139.1	4192±1769.6	4090.8	1829.4	3402±3518.4	114.9	51.4	328±80.8
10.	J	2441.1	1082.7	4230±1684	2481.0	1109.5	1362±1775.2	24.8	11.1355	238±17.6
11.	K	202.9	90.75	429.2±160.64	183.98	82.28	400±128	23.74	10.61	280.6±17.12

TABLE - 34

STATISTICAL RESULTS OF pH VALUE

S. NO	SAMPLING LOCATIONS	NAME OF THE SEASON'S								
		SUMMER SEASON			RAINY SEASON'S			WINTER SEASON		
		S.D.	S.E.	Mean ± variability	S.D.	S.E.	Mean ± variability	S.D.	S.E.	Mean ± variability
1	A	0.296	0.130	7.488±0.230	0.268	0.199	7.4800±0.184	0.295	0.132	7.42±0.216
2	B	0.2167	.0965	7.520±0.144	0.1923	.0862	7.42±O.144	5.4826	2.452	7.46±0.0479
3	C	0.188	0.084	7.508±0.1296	0.236	0.106	7542±0.1896	0.1245	0.0557	7.41±0.080
4	D	0.249	0.11135	7.480±0.176	0.187	.0836	7.5±16	.0961	.0430	7.44±0.0719
5	E	0.444	0.1985	7.604±0.3632	0.436	0.195	7.488±0.3744	0.0525	.0235	7.052±0.0456
6	F	0.0974	.0436	7.57±0.076	0.1658	.0741	7.45±0.119	0.230	0.103	7.390±0.156
7	G	0.0706	0.0316	7.6±0.0399	0.0500	0.0223	7.45±0.0399	0.255	0.1140	7.35±0.199
8	H	0.433	0.194	7.5600±0.288	0.488	0.2142	7.378±0.386	0.130	0.0583	7.0200±0.104
9	I	0.2345	0.105	7.7±0.2	0.260	0.1166	7.66±0.1840	0.240	0.1077	7.34±0.192
10	J	0.240	0.107	7.66±0.208	0.158	0.0663	7.4800±0.1049	6.0836	0.037	7.4800±0.0639
11	K	0.397	0.177	8.13±0.299	0.264	0.118	8.15±0.2	0.2966	0.133	7.79±0.248

TABLE - 35

STATISTICAL RESULTS OF CHLORIDE CONTENTS

S. NO	SAMPLING LOCATIONS	NAME OF THE SEASON'S								
		SUMMER SEASON			RAINY SEASON'S			WINTER SEASON		
		S.D.	S.E.	Mean ± variability	S.D.	S.E.	Mean ± variability	S.D.	S.E.	Mean ± variability
1	A	6.06	2.71	39.4±4.05	9.07	4.06	29.46±6.95	6.34	2.83	28.2±4.9
2	B	11.9	5.32	44.2±9.06	16.11	7.20	35.8±13.20	6.65	2.97	29.4±5.7
3	C	14.4	6.43	48.9±11.93	14.90	6.67	39.6±10.7	4.62	2.1	32.8±3.37
4	D	14.7	6.6	51.46±11.47	17.5	7.81	39.5±12.18	4.81	2.15	33.8±4.16
5	E	30.2	13.5	73.6±25.1	29.7	13.28	52.62±21.54	16.2	7.23	34.2±12.24
6	F	13.9	6.25	46.9±10.16	6.5	2.90	28.6±4.8	6.3	2.81	30.84±5.008
7	G	4.7	2.10	42.6±3.81	7.51	3.36	26.7±5.26	9.73	4.35	26.2±6.72
8	H	24.3	10.9	62.02±20.82	26.14	11.7	46.4±18.2	7.64	3.42	47.42±5.30
9	I	33.5	15.02	76.28±28.3	41.9	18.8	82.5±34.9	5.12	2.3	34.5±3.8
10	J	18.4	8.2	57.2±14.63	25.7	11.5	38.4±18.26	9.83	4.4	29.2±6.64
11	K	10.9	4.90	35.14±8.60	8.74	3.90	30.6±6.02	3.3	1.46	23.68±2.85

TABLE - 36

STATISTICAL RESULTS OF TOTAL HARDNESS

S. N.	SAMPLING LOCATIONS	NAME OF THE SEASON'S								
		SUMMER SEASON			RAINY SEASON'S			WINTER SEASON		
		S.D.	S.E.	Mean ± variability	S.D.	S.E.	Mean ± variability	S.D.	S.E.	Mean ± variability
1	A	29.58	13.23	172.46±20.98	64.36	28.36	133.8±47.4	14.11	6.44	132.8±9.92
2	B	19.45	8.7	143.8±150	20.1	8.99	144.1±16.4	16.69	7.46	154.4±12.4
3	C	25.70	11.53	139.6±19	15.36	6.874	148.72±13.18	18.87	8.441	134.0±12.9
4	D	16.70	7.471	143.8±15.0	11.73	5.246	147.8±9.47	17.01	7.609	133±11.6
5	E	8.221	3.676	139.6±19.3	61.26	27.39	346.9±42.9	38.71	17.31	346±30
6	F	21.30	9.527	166.32±17.384	23.65	10.57	148.08±14.94	10.45	4.675	130.6±8.72
7	G	32.01	14.31	154.74±22.59	21.37	9.558	142.68±14.94	20.76	9.286	135.8±15.3
8	H	45.32	20.26	279.16±31.464	79.78	35.67	250.02±68.456	20.97	9.378	318.6±15.6
9	I	93.37	41.75	365.06±66.024	127.267	56.91	417.98±100.016	36.89	16.49	211±25.6
10	J	36.89	16.50	180.76±25.904	50.20	22.45	178.72±38.224	16.20	7.248	137.2±12.2
11	K	30.71	13.73	195.22±22.664	32.17	14.38	182.14±24.568	11.68	5.226	153.08±7.296

TABLE - 37

STATISTICAL RESULTS OF TOTAL ALKALINITY

S. N.	SAMPLING LOCATIONS	NAME OF THE SEASON'S								
		SUMMER SEASON			RAINY SEASON'S			WINTER SEASON		
		S.D.	S.E.	Mean ± variability	S.D.	S.E.	Mean ± variability	S.D.	S.E.	Mean ± variability
1	A	46.49	20.79	146.82±38.25601	26.9505	12.0526	133±19.05	16.547	7.40001	120.6±12.32
2	B	16.06	7.183	131.28±12.944	21.247	9.502	137.32±15.776	5.2153	2.332	136.8±3.84
3	C	33.68	15.06	14.02±27.44	29.48	13.18	137.92±24.344	12.30	5.500	121.6±8.08
4	D	24.33	11.10	137.44±16.528	19.62	8.775	139.08±14.464	16.0156	7.162	120±11.2
5	E	91.82	41.06	317.84±75.008	70.39	31.48	339.42±55.216	76.97	34.42	326.6±59.6
6	F	31.83	14.23	165.48±24.384	37.98	16.98	146.3±31.88	6.73	3.01	125.4±5.28
7	G	28.18	12.60	140.38±18.896	23.37	10.45	129.4±17.12	12.98	5.808	129.2±10.6
8	H	47.18	21.10	206.44±29.424	39.05	17.46	223.16±30.968	19.07	8.529	231.4±13.3
9	I	111.251	49.75	312.68±79.344	93.31	41.72	278.5±67.	5.449	2.431	131.2±3.7600
10	J	20.11	8.997	167.78±15.096	38.05	17.01	156.16±32.192	11.30	5.054	135.2± 9.360
11	K	29.82	13.33	220.44±25.072	30.61	13.68	199.66±20.136	11.06	4.946	181.22±7.864

TABLE - 38

STATISTICAL RESULTS OF BICARBONATE CONTENTS

S. NO	SAMPLING LOCATION	NAME OF THE SEASON'S								
		SUMMER SEASON			RAINY SEASON'S			WINTER SEASON		
		S.D.	S.E.	Mean ± variability	S.D.	S.E.	Mean ± variability	S.D.	S.E.	Mean ± variability
1	A	49.644	22.201	141.02±39.624	31.69	14.172	124.68±21.768	21.319	9.534	118±14.4
2	B	16.076	7.189	128.88±12.976	23.78	10.637	129.66±18.928	13.304	5.949	125±10
3	C	39.74	17.773	135±31.2	29.48	13.184	137.92±24.334	19.728	8.822	112.8±15.84
4	D	30.172	13.493	131.42±18.968	19.62	8.775	139.08±14..464	22.605	10.10	111±17.6
5	E	91.829	41.067	317.84±75.008	67.97	30.400	308.22±48.032	78.954	35.30	315.4±64.08
6	F	38.561	17.245	160.08±32.064	36.77	16.436	145.9±3100	6.220	2.782	125.8±4.96
7	G	27.945	12.497	140.18±18.288	25.56	11.43	127.2±20.56	16.985	7.596	126±13.2
8	H	48.111	21.516	202.88±30.848	39.14	17.504	224.32±31.176	25.975	11.60	227.4±18.16
9	I	116.27	51.999	310.28±32.224	92.93	41.563	2737±66.96	9.418	4212	128.8±6.319
10	J	25.020	11.199	165.28±17.296	39.51	17.671	152.7±34.360	14.046	6.281	133.6±11.12
11	K	30.146	13.482	220.24±25.312	30.36	13.581	199.86±20.056	11.316	5.060	181.22±7.864

TABLE - 39

STATISTICAL RESULTS OF FREE CARBONDIOXIDE

S. N0	SAMPLING LOCATIONS	NAME OF THE SEASON'S								
		SUMMER SEASON			RAINY SEASON'S			WINTER SEASON		
		S.D.	S.E.	Mean ± variability	S.D.	S.E.	Mean ± variability	S.D.	S.E.	Mean ± variability
1	A	4.031	1.803	3.768±3.321	3.815	1.706	4.048±3.238	2.292	1.025	4.044±1.61
2	B	2.605	1.165	3.332±1.866	2.350	1.051	2.444±1.955	2.725	1.218	1.76±2.112
3	C	3.403	1.521	3.664±2.931	2.364	1.057	5.474±1.605	3.407	1.524	3.592±2.87
4	D	4.419	1.976	3.332±3.198	2.453	1.097	7.02±1.4	3.886	1.737	4.256±3.45
5	E	2.968	1.327	12.896±2.076	5.228	2.338	8.136±3.6	5.383	2.407	9.168±3.67
6	F	4.008	1.792	4.544±3.004	3.547	1.586	4.916±2.524	1.432	0.640	3.796±1.1952
7	G	2.89	1.293	5.068±2.4	2.542	1.137	3.244±1.652	2.680	1.198	3.604±2.0448
8	H	6.199	2.772	6.032±5.3	4.956	2.216	10.612±3.54	5.47	2.448	9.559±3.82
9	I	7.044	3.150	8.66±5.44	14.24	6.370	16.56±12.02	8.595	3.84	8.412±7.35
10	J	4.738	2.118	4.74±3.28	4.623	2.067	4.76±3.36	2.685	1.200	3.5±2.08
11	K	2.986	1.35	7.778±2.0312	2.130	0.952	5.94±1.46	2.240	1.002	7.00±1.906

TABLE - 40

STATISTICAL RESULTS OF TOTAL CARBONDIOXIDE

S. NO	SAMPLING LOCATIONS	NAME OF THE SEASON'S								
		SUMMER SEASON			RAINY SEASON'S			WINTER SEASON		
		S.D.	S.E.	Mean ± variability	S.D.	S.E.	Mean ± variability	S.D.	S.E.	Mean ± variability
1	A	788.0	352.4	733.22±635.34	424.6	189.89	524.28±327.38	426.3	190.6	509.042±368.02
2	B	326.8	146.1	548.2±262.13	296.2	132.47	438.6±237.3	379.6	169.804	395.94±286.608
3	C	611.7	273.5	724.53±502.244	365.6	163.51	845.9±250.2	380.9	170.3	705±247.6
4	D	376.3	168.2	685.06±239.62	683.231	305.55	932.08±490.144	186.114	83.23	883.339±149.192
5	E	1998.6	893.8	4483.4±1594.7	3326.3	1487.6	3989.3±2747.6	17.32.	774.6	3159.2±1302.1
6	F	857.6	383.5	971.29±660.24	805.1	360.09	940.78±575.33	183.6	82.14	628.3±159.6
7	G	521.1	233.0	872.48±434.6	372.4	166.56	547.64±248.68	328.5	146.9	666.64±27.1
8	H	1559.9	697.6	1542.7±1338.8	1282.91	573.7	2681.1±892.19	1323.2	591.7	2498.9±928.8
9	I	4763.9	2130.5	5587.5±3555.0	5084.7	2273.95	208.9±4155.7	1446.4	646.8	1425.9±1210.5
10	J	938.7	419.8	967.3±679.6	994.1	444.5	807.7±686.27	443.6	198.38	612.2±351.61
11	K	822.2	367.7	1944.0±643.15	710.9	317.9	1410.8±497.86	393.2	175.8	1431.9±331.4

TABLE - 41

STATISTICAL RESULTS OF DISSOLVED OXYGEN

S. N0	SAMPLING LOCATIONS	NAME OF THE SEASON'S								
		SUMMER SEASON			RAINY SEASON'S			WINTER SEASON		
		S.D.	S.E.	Mean ± variability	S.D.	S.E.	Mean ± variability	S.D.	S.E.	Mean ± variability
1	A	1.124	0.50	7.36±0.75	0.56	0.38	7.41±1.14	0.343	0.154	8.64±0.3
2	B	1.114	0.58	7.36±0.79	0.84	0.38	7.3±0.6	0.15	0.06	8.82±0.104
3	C	0.954	0.42	7.40±0.68	0.515	0.23	7.7±0.36	0.36	0.16	8.56±0.27
4	D	1.15	0.52	7.1±0.8	0.503	0.22	7.76±0.34	0.404	0.18	8.66±0.312
5	E	1.5	0.66	5.6±1.08	1.56	0.7	6.36±1.13	0.55	0.25	7.36±0.408
6	F	1.11	0.5	7.02±0.75	0.64	0.29	7.56±0.51	0.182	0.08	8.84±0.128
7	G	1.108	0.5	7.02±0.75	0.7	0.30	7.84±0.51	0.181	0.08	8.76±0.128
8	H	1.19	0.53	6.62±0.83	0.95	0.43	6.92±0.74	0.804	0.36	7.48±0.57
9	I	1.23	0.551	6.54±0.85	1.201	0.54	7.16±0.95	0.73	0.32	8.5±0.52
10	J	1.16	0.52	6.92±0.78	0.95	0.423	7.76±0.66	0.67	0.3	8.56±0.464
K	K	1.57	0.70	7.81±1.3	1.35	0.60	7.53±1.05	0.35	0.16	9.66±0.3

TABLE - 42

COMPARISON BETWEEN 10 SAMPLING LOCATIONS MATATILA RESERVOIR AND TUBE WELL WATER

SN.	PARAMETERS	SAMPLING LOCATIONS (Average Value of 12 month's Sept. 1995 to Aug. 1996)											Tube well water	INDIAN STANDARDS Acceptable to objectionable Limits
		A	B	C	D	E	F	G	H	I	J	K	L	M
1	ODOUR	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable	Nonobject-ionable	Earthy& Musty Smell	Nonobject-ionable	Nonobject-ionable	Earthy & musty smell	Earthy & musty smell	Object-ionable Smell	Earthy smell	Nonobject-ionable	Nonobject-ionable
2.	TASTE	,,	,,	,,	,,	unplae-sent taste	,,	,,	unplaesent taste	unplaesent taste	,,	,,	,,	,,
3.	COLOUR	Colourless	Colourless	Colourless	Colourless	Slight-Yellow	Colourless	Slight-yellowish	Greenish yellowish	yellowish	Colourless	yellowish	Colourless	2.5 To 10 Unit
4.	TEMP. (°C)	20.7°C	20.8°C	19.5°C	19.6°C	20.5°C	20.6°C	19.7°C	21.6°C	20.5°C	20.5°C	24.0	30.0	
5.	ELECTRICAL CONDUCTIVITY (Micromhos)(Mg/L)	$2.4X10^2$	$2.41X10^2$	$2.57X10^2$	$2.45X10^2$	$5.8X10^3$	$2.45X10^3$	$2.41X10^3$	$5.9X10^3$	$3.25X10^3$	$2.48X10^2$	$2.32X10^2$	$1.51X10^4$	
6.	pH VALUE	7.53	7.45	7.50	7.42	6.99	7.50	7.40	6.90	7.50	7.50	7.70	6.85	6.5 To 9.2
7.	CHLORIDE CONTENTS (Mg/L)	27.50	27.90	33.50	33.10	33.50	29.50	24.90	46.60	50.90	29.10	20.00	210.00	200 To 1000
8.	TOTAL HARDNESS (Mg/L)	141.30	151.0	134.80	117.0	346.3	130.5	121.0	320.8	264.3	137.8	120.0	650.0	200 To 600
9.	TOTAL ALKALINITY (Mg/L)	119.5	131.6	118.6	119.1	337.0	124.1	125.8	233.3	151.3	132.8	148.0	322.0	
10	CARBONATE CONTENTS(Mg/L)	21.0	7.3	6.1	6.0	3.3	0.0	2.3	0.0	2.0	0.0	0.0	0.0	250 To 500
11.	BICARBONATE CONTENTS(Mg/L)	117.3	122.1	125.0	113.0	327.6	124.1	121.3	230.0	149.3	131.8	148.0	322.0	500 To 1000
12.	FREE CARBONDIOXIDE (Mg/L)	4.69	2.05	4.23	4.1	9.3	3.49	3.6	10.10	12.30	3.9	6.5	24.6	
13.	TOTAL CARBONDIOXIDE (Mg/L)	606.8	378.7	740.0	825.0	10870.4	543.1	4647.4	7380.0	624.0	1091.2	8217.4		
14.	DISSOLVED OXYGEN(Mg/L)	8.5	8.5	8.4	8.5	7.0	8.6	7.9	8.0	8.1	8.0	8.5	4.9	

February at sampling location C & Maximum value in September at sampling location E. In general low values were obtained in Winter&high values in summer & rainy seasons. Carbondioxide enters the water partly direct from the atmosphere and partly with precipitation and other inputs , but largely due to infiltration through the soil as well as Metabolic activity of the organisms in water. During aerobic decomposition of organic residues Carbon is Mineralised to Co_2 , while during anaerobic decomposition Carbondioxide & Methane are both formed in roughly equal amounts. The Co_2 budget, in general depends on the nature the wastes being added to the aquatic bodies (Chandraprakash et. al., 1978 Palharya & Malviya 1988). A state of inverse relationship between Co_2 & D.O was observed by the present workers, the same situation has been reported by many workers.i.e. Mandal & Hakim (1975); khan et. al., 1978& nalin. K. Shastree et. al., 1991.etc.

Dissolve O_2 content in tap water supplies of Jhansi showed minimum value of 4.0 mg/L at sampling location E in the month of June & maximum value at sampling location D of 9.2 mg/L in the month of February. The amplitude of fluctuation were low. During the period of investigations a general tendency was found at all sampling locations in which Dissolve oxygen increased after summer and decreased afrer winter. As will be evident from the table 23 that during summer the value of dissolved oxygen were low where as in winter season its value remained high i,e. Maintaining an inverse relation ship with Co_2 a pointed in the earlier paragraph. Dissolved oxygen is essential for all aerobic organism's metabolic activity. It effects the soluiblity and availability of many nutrients and then for the productivity of aquatic ecosystem. Oxygen balance in water bodies are affected by input due to atmosphere and photosynthesis & output due to respiration, decomposition and mineralisation of organic matter as well as losses to atmosphere. Thus the oxygen balance in water becomes poorer as the input of oxygen at the surface and the photosynthetic activity decreases and as the metabolic performance of the heterotroaphic organisms become greater. During our studies as already stated oxygen maximas has been observed in winter &

minimum in summer months This indicates a state of inverse relationship between dissolve oxygen & water temperature. Decomposition of organic matter may be an important factor in the comsumption of D.O. which becomes more vigorous in warm season. The phenomenol of reoxygenation of water in monsoon period mey be due to circulation & mixing by inflow after monsoon rains. With the progress of winter D.O. increased to its higher values which may be due to circulation by cooling & draw down of dissolved oxygen in water. Similar view are of Zutshi & Vass 1978. Yadav et. al., 1987; Bagde & Verma 1985; Rai 1978; Nalin k. Shastree 1991.

The annual oxygen budget was low and biological process were observed. The state of dissolved oxygen depends upon many factors and generalization are difficult to be made. Sreenivasan 1968 observed it as productivity linked phenomenon .The lower oxygen amount came also be attributed to discharge of various sewage channels and humen interferances, during planktons which release various chemicals that are oxidized by the ponds disoolved oxygen.

Dissolved oxygen is important parameter for water quality assesment. Nonpolluted waters normaly remain saturated with dissolved oxygen. It decreases due to the presence of wastes. Inorganic reducing aqents like hydrogen sulphide,ammonia, nitrates decrease dissolved oxygen in water. Similar to the observation of the author Saxena et. al., 1966 found lowest value of dissolved oxygen during summer. Very low concentration of the dissolved oxygen was found at polluted sites by Palharya&Malviya 1988, in river Narmada at Hoshangabad.

During the period of analysis the present worker were found that organic matter was generally present in high proportion during March to August 1996. As such the biochemical oxygen demand was analysed during these six months. The data's of which are presented in Table-25. The B.O.D. value during the period of investigation ranged between 0.9 to 1.29 mg/L. During the investigation very small variation in B.O.D. values were found at different

sampling location's The values were higher at sampling location's E&I, when compared with the other sampling location's during all the six months. This indicates that higher organic matter in the water's of pipelines leading to such location's B.O.D.is an important index for the assesment of relative oxygen requirement of wastes and even quality receiving water. It is the amount of oxygen required for the biochemical degradation of organic material and the oxygen used to oxidize inorganic material. Low values of B.O.D in colder monthes may be due to lesser quantity of total solids , dissolved solid or suspended solids in water as well as to the number of microbial population. Generally B.O.D count was found to be higher during June as compared to the other months.

Planktonic population undergo regular seasonal fluctuations as will be evident from the tables 26,27,28,29. This constitute what is called a "Cyclic succession Pulses" and reach a "Climax" which vanishes soon in aquatic bodies and than reappear again. This succession of planktonic population is thus quite different from terrestrial communities where climax is retained and has to go a long way.

The phytoplanktonic flora of tap water supplies showed prominence of myxophyceae desmids and few other species. Planktonic population and accumulation of organic & inorganic material often lead to turbidity of water. Sometimes there population suddenly flare off and resulted in water bloom which was due to multiplication of species or combination of species and was confined to summer months of May, June. This may be due to the scarecity of water as most of the water is supplied during the prior months of or due to excess evaporation. During such multiplication some members of Chlorophyceae, Cyanophyceae, Bacillariophyceae or Euglinophyceae multiplied rapidly and their sticky walls adhere to each other and form a dence mat or scum on the surface, these algal forms were often responsible for bad taste and odour of water. The pipeline water supply had fewer number of organisms as compare to the reservoir water because of stagnation, filteration and treatment. During the study

period 20 algal species were recorded out of which six belong to Cyanophyceae, 7 to Chlorophyceae, 1 to Euglinophyceae and 6 to Bacillariophyceae. There seasonal variation has been shown in Table -26 to 29. Neumarically significant were Microcystis aeruginosa, Anabaena constricta, Meresmopedia punctata, Chlamydomonas sp, Chlorella vulgaris, Scenedesmus acuminatus, Cyclotella operculata, Melosira varians; Navicula radiosa, Pinnularia viridis and Synedra affinis.

During our analysis out of 12 sampling locations water from sampling locations E, and K showed abundance of algal forms hence these locations were selected for detail analysis. Water from Matatila reservoir brought through pipelines to Babina filter plant had $185x10^3$/L as maximum populations of Cyanophyceae and 150x103/L , $72.5x10^3$ per litre and $20x10^3$ per litre were the maximum populations of Chlorophyceae, Bacillareophyceae & Euglinophyceae respectively. At sampling location 'I' that is city area the maximum population of Chlorophyceae, Cyanophyceae, Bacillariophyceae and Euglinophyceae were higher as compare to the sampling location E that is 'Bada Bazar' area. Seasonal population of chlorophyceae were found to be maximum in winter followed by summer. While maximum population of Blue green algae were found in late winter & summer season. In the present investigation it was found that Chlorophyceae were dominent followed by Cyanophyceae, Bacillariophyceae and Euglinophyceae. Euglinoids were more or less uniform at different months. General trends in increase of population can thus be arrange in the sequence of Euglinoid<diatoms<blue green algae<green algae at all locations studied.

Green algae which were found through out the year were Chlamydomonas sp., Chlorella vulgaris, Scenedesmus quadricauda, Pediastrum simplex. Among the Bacillaricophyceae Cyclotella operculata, Melosira varians, Navicula radiosa, Pinnularia viridis, Synedra affinis, Euglena remain fluctuating through out the study period. During summer bulk of phytoplankton increase with in rise in temperature. With the initiation in of rains there number felt due to dilution but by the end of July there population

increased Oscillatoria, Phormedium, Spirogyra show an 'entrophic indication while Melosira, cyclotella, Synedra show 'oligotrophic' indication. Oscillatoria Navicula, Nizshia are often regarded as indicator of waste water. Minimum population of phytoplanktons during rainy period were also observed by Mittal & Sengar 1991. These were in maximum number during winter season.

Cunductivity of water favoured the growth of Osillatoria and Chlamydomonas there moderate quantity favoured the growth of Merismopedia Phormedium, Pediastrum, Scenedesmus and Cosmarium. Hardness favour the growth of Cosmarium Pediatrum and Scenedesmus. Dissolved oxygen enhance the growth of Merismopedia, Chlamydomnas Scenedesmus, Cyclotella, Melosira & Synedra. These findings were in accordance to the findings of Mittal & Sengar 1991.

Bacteriological analysis was done during the present course of study without which the potability of tap water supply could not be acertained for this the present worker first estimated the total viable count of bacteria to have an idea about, the eutrophication of reservior, quality of water being supplied through taps to different localities of Jhansi town, efficiency of operation for removing or distroying bacteria at filteration plant. Then M.P.N, cannot for coliform bacteria were done to study the pollution level and santry conditions.

Total viable cannot of bacteria was done by standard plate count methods in order to eleminate various short commings and to get the count of maximum no. of viable bacteria number of medias like eosin methylene blue agar, McCkonkey agar nutrients agar, soil extract agar etc. were used and two separate sets of plates for each sampling location, were incubated at $35^0 \pm 0.5^0$C and 20^0C$\pm .5^0$C for 24 to 48 hrs. It was observed that the average total viable count varried from $2x10^2$ to $340x10^2$/ml at different sampling locations. In general the total count of bacteria dropped during winter months attaining their lowest value in January during summer months the population increased and attained their peak value during June. Water from sampling location 'K' i.e. reservior water comming from Matatila, had significantly higher values as compared to

other sampling locations of tap water supplies. However the trend remained the same i.e. higher during the summer & gradual lowering down during the rainy & winter seasons. It appears that the decline in the number of bacteria in tap water supply might be due to sedimentation, filteration & chlorination treatments met at the filter plant. During the course of investigations the present worker came accross wiht some forms of actinomycetes which appeared in the same platesment for bacterial isolations. Williams et. al. 1984 have a claimed to isolate Arthrobacter, Corynebacterium Mycobacterium & Nocoardia species in fresh water. The actinomycetes & their significance in aquatic habitate have been studied by Burman 1973, Higher member of actinomycetes in streams and rivers as compared to lakes & reservoirs has been reported by Willoughly 1976 & Niemi et. al., 1982. The also found abundent actinomycetes in eutrophic & mesotrophic lakes than oligotrophic lakes. These must be responsible for Earthy or musty, taste & odour found by the present worker. As Gerber & Lechevalier, 1965 found geosmin substance in the cultures of Streptomyces. Gerber 1979; Goodfellow & William 1983 found the substance in Streptomyces tainted water. Actinomycetes were detected in water distribution system by Silvey & Roach 1975, Lechevalier, et. al., 1980. The resistance of actinomycetes spores to chlorination treatment (Burman 1973) has been the main reason for their presence in water distribution system.

In order to study the potability of water and sewage pollution M.P.N count of the total coliforms were detected by the present worker for presumption Lactose broth was used at 37^0C and confirmed in brillient green lactose broth with a complete test in Eosin - Methylen blue medium. The total MPN count of coliform bacteria ranged between 12 per 100 ml to 210 per 100 ml in the tap water supply while the reservoir it varied from 210 to 2400 per 100 ml. The counts of coliform bacteria followed the same pattern as was observed in the total viable count of bacteria i.e. in both the counts bacterial number were lower in january droped during October to January (winter season) and attained there lowest average value in a month of January. From February onwards i.e., during

summer the count continously increased and attained a peak value in the month of June. Bacterial population was lower in monsoon lowest in winter and highest in summer. Besides the other physico-chemical factors mild earliest monsoon rain during June might have increased the bacterial population to the maximum later on as the subsequent rain continue during July, August or September the water body got diluted and the count decrease.

Bacterial population both total viable count and coliform count has been found to be influence by the physical & chemical conditions of tap waters of Jhansi. There existed of direct correlation between the electrical conductivity and the bacterial count with decrease in the electrical conductivity and the bacterial conut with decrease in the electrical conductivity during winter months bacterial count also decreased with increase in electrical conductivity during summer months bacterial count also increased.

Temperature had a considerable influence on the bacterial count. Higher temperature favoured there growth while lower temperature retarded there growth. This showed a positive influence of temperature on the bacterial population. Similar positive influence have been found with total hardness.

Dissolved oxygen increased during winter months, bacterial count decreased. With decrease in dissolved oxygen concentration during summer months bacterial counts increase thereby indicating an inverse relationship between them. Occasional presence of E. coli has been found by the present worker and its presence was noted by IMViC tests. This is defenately a indication of sewage mixing up of water specially at the sampling station E&I.

SECTION - 7

CONTROL MEASURES

SECTION-7
SUGGESTIVE CONTROL MEASRE'S

Nearly half of the population live in urban area and tap or ground water is the main source of potable water to them at Jhansi. Due to rapid urbanization, industrialization and intensive agriculture practices, the raw water sources are abused and the net result is the deterioration of water quality and treatment management. The draught during summer and pollution due to seawage outlets make the situation further complicated. Since tap water is mainly used for potable water in the town it is necessary to derive probable solutions for clean and safe drinking water.

Though physicochemical and biological information has been collected during the present work but there are many factors which could lead to deterioration during transit between place of treatment and the users. Some of these factors are (1) Persistence of living organisms and substance in water that can serve as food for them. (2) Existence of poorly protected or designed sections at the distributory network (piping, reservoir, values). (3) insufficient or absence of monitoring in the distributor network and (4) in sufficient maintenances operation in the network. Because human health is concerned it is absolutely necessary to have a distributory system which could provide clean and safe drinking water.

In order to eliminate hazards due to algae bloom and turbidity which is some times seen in late summer waters in city area it is necesary to have properly designed hydrological programme. Belsare 1887 reviewed the art of water treatment for demestic use. Before designing any such programme one should be carefull with the turnovers, specially during the summer months when there inadequate water at the filtering plant.

Most of the bad odours in drinking water which frequently exists. During summer is due to decomposed organic matter and living organisms. To supply protected water excess chlorination is done. Although it kills the living organisms

but produces hallogenated compounds by its reaction with the organic matter. Raw water pumped to storage tank must be flucculated by alum treatment before sending to sedimentation in properly built settling basins. There flocs reach the filters and block them. Which is more common during hot season the same was observed by Belsare & Prasad 1984 at Bhopal water works. During hot season raw water is heated up during day time that cause temperature difference in water at source and treatment plant and retention time of 3 to 5 hrs. In flocculators. Aeration of water and destratification of temperature could help in solving the problem.

As actinomycetes are resistant to chlorination treatment (Burman 1973) hence proper clearing operation should be done at water works so that organic matter in the form of plant litter should be removed periodically.

After sedimentation water is sent to filter beds at slow sand and rapid sand filters. The rapid sand filter which is in operation at Babina filter plant but it often gets encrusted by the floc. Which make its use difficult. It becomes necesary to remove the organic & inorganic metter over the sand by exposing it for drying once in a fortnight. Thus properly sedimented water should be sent to filter beds to avoid deposition of floc. These flocs are suitable media for bacterial flora hence their population will increase even though more alum doses are used to remove turbidity. The persistence of more bacterial colonies during hot season and monsoon is due to insufficient chlorination at Jhansi filter plant. To reduce the cost of turbidity removal certain coagulant aids can be added along with alum. Polyacrylamide is one such coagulant aid found more economical for hot climate (Prasad & Belsare 1982).

The distributory system should be properly looked after as contamination of water with coliform bacteria in distributory system was noticed by the present worker (Table 29) because of entry of sewage from sewer lines into distributory pipe, at such water is not safe for drinking purpose. Thus plate counts should be done as a reliable index of bacterial contamination & unsafe water. The method which is not be followed at Babina analysing laboratory. The existence of

harmless basic level of plate counts in finished water permits the comparison of differences in potential bacterial growth and helps the operators to maintain distributory & filtering systems.

Apart from in adequacy and inaccessiblility of water specially during summers at Jhansi contamination adds chronic misery to the rural population. Water-borne disease develop as a result of pathogenic organisms. At present the total coliforms counts despite their well recognised short comings are the commonly used indicators of water safety. The present author made a priliminary effort to control coliform organisms in drinking water. Cup plate & filter paper discs were used to test their sensitivity against 3 commonly used antibiotics i.e., Ampicillin, Chloramphenicol & Tetracycline. Allergic response of the antibiotics were considered before making sensitivity test i.e., Penicillin, Sulphur. drugs, Streptomycin were not considered as these are not acceptable to all persons. The author found the trend of increased in sensitivity in the sequence of Chloramphenicol < Ampicillin < Tetracycline. The validity of the test is doubtful as for pathogenic orgainsm these antibiotics may not show the same trend of sensitivity. This was just an attempt to point towards a need of some substitute in the form of antibiotic substance which could help to protect drinking water from pathogenic organisms.

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SECTION - 8

GENERAL SUMMARY

SECTION - 8

GENERAL SUMMARY

Jhansi situated at 25^0 - 27^0 North and 78^0 - 35^0 East is about 271 meters above mean sea level. Its population of 3.5 Lacs requires 69 mld water but is supplied with about 27.0 mld water out of which 9.5 mld comes form Matatila reservoir, 13.6 mld from Pahuj reservoir and about 3.910 mld from tube wells, through pipe line distribution system extended to a length of 371 km. The town thus faces an acute water scarcity because of low & erratic rainfall & high run off due to low infilteration & retention. Because of this availability of ground water is also limited & unreliable.

The present investigations were carried out from Sept. 1995 to Aug 1996 having a study area extended from Lehar Temple outside Datia gate, Unnao gate in the North to Nagra, Pulia No. 9 & Cantt in the south and Pahuj dam in the East to Narain Bagh, Medical College in the west (map 1&2) Fortnight samples were collected from 12 sampling locations stationed in such a manner to cover as much distribution system as possible.

Seasonal variations in various physico-chemicals & Biological properties were investigated from water samples collected form the above sampling locations datas were collected for Odour, taste, Color, Temperature, pH, electrical conductivity, chloride content, total hardness, total alkalinity, carbonate contents, bicarbonate contents, free carbondioxide, total carbondioxide, dissolved oxygen, Biochemicaly oxygen demand, phytoplankton and bacteriologial variatons.

Odour in drinking water was due to the organic matter & microscopic organisms present in water odour was observed from samples obtained from tap water rather then tube well water. The presence of Actinomycetes during sampling points towards its possible role in making earthy odour, this is as per observation made by Silvey & Roach 1975, William et. al., 1984, Wood et. al. 1985.

Transparency or turbidity makes the water unfit purpose this was caused by suspended matter present.

Water temperature during the study period varied from 14^0C to 40^0C during January & June respectively. This had an effect on the variation in all biochemical & biological reactions. It enhanced both Phytoplankton and bacterial species composition, density, frequency & succession together with changes in the chemical environment.

pH during the investigation period ranged between 6.89 to 8.0. Maximum values were found during June maximum values were recorded during summer low values during winter & monsoon months in the tap water supplies of Jhansi.

Conductivity profile also showed low values in winter months & high values during summer months. This was due to increased concentration of salts in summer because of evaporation of water during rains dilution resulted which brought down the value of electrical conductiviy. High level of conductivity were recorded in tube well water as compared with tap water supples was correllated with pollution & mixing of under ground water. As higher values of conductivity tap water supples of the reservoirs, specially at sampling locations E&I of tap water.

Chloride contents of tap water supply ranged between 16.00 mg/L, to 133.0 mg/L generally minimum values were obtained during September or November & maximum values during May or June. We could not find a definite any pattern of chloride fluctuations. Variations may be due to precipitation, evaporation, human activity or municipal waste. High chloride content was correlated to the coliform organisms.

Data's recorded on total hardnes could not show any pattern of rice or fall it remained fluctuating. Through out the course of study without any defenite trend. Total alkalinity was generally high during summer & low during winter Months. Its rice was correlated with higher production. Bicarbonate alkalinity was mainly responsible for higher values of alkalinity in tap water supplies of Jhansi.

Free carbon dioxide generally was found to be maximum during May or June in tap water supplies of Jhansi. Highest variation was observed at sampling location I during rest of the period the values fluctuated. Maximum value noted was 31.68 mg/L while the minimum value nil was observed in all the sampling lication in one or the other months of the study period.

Total carbondioxide showed a wide range i,e. From 91.0 to 8415.0 mg/L Maximum values were generally found during summer months while minimum value during late monson or winter months.

Analytical data's for dissolved oxygen in tap water supplies showed a general trend to increase after summer & decrease after winter. Result in the table and histograms indicates low values of disolve oxygen during June and higher values during winter. Its value ranged from 4.0 mg/L to 9.2 mg/L.

Biochemical oxygen demend was analysed for 6 month i.e. from march 96 to Augest 96. Because organic matter was generally present during this period while during the rest of the period water was generally clear. Very small changes in BOD values could be found by the present worker during this period.

Detailed Phytoplanktonic study was conducted in the water of E.I.&K sampling locations because of the abundance in these sampls. Alltogether 20 algal species were recorded out of which 6 belong to Cyanophyceae, 7 to Chlorophyceae, 1 to Euglinophyceae & 8 to Bacillaiophyceae, During the present study 9 species were found most dominant. Monthly variations in the total population of each groups of algae have been expressed in the table 26-29. Seasonal population of chlorophyceae were found to be maximum in winter followed by summer. Maximum population of blue green algae were found in late winter & summer seasons. During the present study Chlorophyceae were dominant followed by Cyanophyceae, Bacillariophyceae & Euglenophyceae. Euglenoid were more or less uniform in their abundance The general sequence of increase in population can be Euglenoid Diatoms < blue green algae < green algae.

Among the Cyanophyceae Anabaena constricta showed its highest population during summer decreased during May &sub-maximum during winter. Arthospira sp was more frequent in the reservoir water as composed to the tap water Microcystis aeruginosa though present quit abuudently but it did not resulted in causing the water bloom. It showed two maxima one in June & other in December. Oscillatoria sp was found only in the reservoir water, and remained frequent during rains & winter but disappeared during summer. Phormidium appered quit similar to Oscillatoria in occurrence.

Among chlorophyceae Chlamydomonas. Sp. appeared in June and increased till August. In September it declined & then totally disappeared in winter & summer Chlorella vulgaris was found asuceted with Microcystis and Scenedesmus. It appeared in June after the first shower & increased in number during rains with a maximum in July & August. Cosmarium sp remained occasiolal in appearence Pediastrun simplex was present through out with lowest population in sumer. Scenedesmus sp remained associated with Chlorella vulgaris. Spirogyra sp. appeared in October in the reservoir water increased its number during winter & finally disappeared in summer.

Euglenophyceae was represented by Euglena sp alone it appeared in Nov. and muliplied rapidly in March & April.

Bacillariophyceae form the largest bulk of phytoplankton and were found through out the study period. Its representation was made by Cyclotella operculata, Melosira, Navicula radiosa, Pinnularia viridis and Synedra affinis.

Bacteriological analysis involved the total viable count and the M.P.N. count of total califorms. Both showed similar trend with lowest count during December / January and highest during May / June.

The number gradually increased from its minimum values from December/January to its maximum value in May/June and then again gradually declined to its minimum value.

There existed a direct correlation between both the bacterial count an pH & electrical conductivity of tap water supply. When both pH & electrical conductivity were highest in the month of June bacterial count recorded were also highest. Temperature also had a considerable influence on both the count of bacteria i.e. Higher temperature favoured the growth & multiplication while lower temperature retarded Higher total hardness coincided with higher count of bacteria.

Dissolved oxygen had an inverse relationship with the bacterial count. When dissolved oxygen increased during winter bacterial count decrease. With decrease in dissolved oxygen concentration during summer bacterial count increased.

SECTION - 9

BIBLIOGRAPHY

SECTION - 9

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